

# BERGEY'S MANUAL

# DETERMINATIVE BACTERIOLOGY

BY

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<sup>†</sup> Deceased, October, 1915.



## PREFACE TO SIXTH EDITION

More than the usual amount of time and effort has been given toward making this new edition of Bergey's Manual useful. The volume has been completely revised and is reset in double column format so that each page carries about 20 per cent more type than the pages in the fifth edition. Those who are interested in special groups of bacteria will find something new in the presentation of the relationships in every genus. Because of our rapidly expanding knowledge, changes in the outline classification and text were made necessary. These changes have in every case been made by specialists in consultation with the Editorial Board. Every specialist possesses first hand knowledge of the species in the group that he or she has reviewed.

Because increasing knowledge has shown the fission fungi to be a larger and more diversified group than previously realized, the number of species described has increased from 1335 in the fifth edition to 1630 in the present edition of the Manual. This number does not cover all of the descriptions found in the literature for, as in all other fields of biology, many of the descriptions are so inadequate that the species described cannot now be identified. Many descriptions are obvious or probable duplications of previous descriptions while still others are based on nothing more substantial than the author's belief that he had something new, he having made but little effort to compare his cultures with those found by previous investigators. An indication of the large number of inadequate descriptions will be found by referring to the material in the appendixes to the various groups, and to the index where synonyms and incompletely described species are shown in italics.

The large number of these poorly described species suggests that there has been much unsatisfactory work done in the field of bacteriological taxonomy. Progress in this inadequately developed field is needed as it would help to clarify the approach to desirable research in many fields of bacteriology

It is believed that both teachers and investigators will find the new Source and Habitat index useful. It is important to know what organisms have been described from any given habitat in determining the identity of a described species or whether a given species is new.

The future development of taxonomic work holds several interesting possibilities of increased international cooperation such as between the various National Type Culture Collections and within the International Association of Microbiologists. The Trust Funds provided through the generosity of Dr. Bergey before his death have been used in developing the present edition of the Manual and future funds are to be used in the same way under the management of a self-perpetuating Board of Editor-Trustees.

We are all under obligation to those who have given so freely of their time and special knowledge in preparing this edition of the Manual. Moreover the Editor-in-Chief is under special obligation to his wife, Margaret Edson Breed who has carried the burden of the indexing; to Mrs. Eleanore Heist Clise who has given invaluable service in bibliographical research, in proof reading and other ways; and to his secretary, Miss Mande Hogan, who has cared for many difficult manuscripts and a voluminous technical correspondence.

Many binomials not previously mentioned in the Manual will be found in the Index of Genus and Species Names. Each new name means that there is a new bibliographic reference in the text. Practically all of the incomplete references of previous editions and all new references have been examined in the original, something that is essential in all accurate taxonomic work. The index of names is the most complete list that has appeared in the literature and should always be consulted before new genus or species names are proposed.

This edition of the Manual has been more than four years in press, thanks to the care that has been taken to make it complete and useful. Throughout, the Editorial Board has had the cooperation and understanding help of the publishers of the book who themselves have been forced to meet and overcome the trying difficulties of the war years.

The plan of the present book is such that it will be found useful both to teachers and research workers.

ROBERT S. BREED, Chairman E. G. D. MURRAY A. PARKER HITCHENS Board of Editor-Trustees.

April, 1947.

#### PREFACE OF FIRST EDITION

The elaborate system of classification of the bacteria into families, tribes and genera by a Committee on Characterization and Classification of the Society of American Bacteriologists (1917, 1920) has made it very desirable to be able to place in the hands of students a more detailed key for the identification of species than any that is available at present. The valuable book on "Determinative Bacteriology" by Professor F. D. Chester, published in 1901, is now of very little assistance to the student, and all previous classifications are of still less value, especially as earlier systems of classification were based entirely on morphologic characters.

It is hoped that this manual will serve to stimulate efforts to perfect the classification of bacteria, especially by emphasizing the valuable features as well as the weaker points in the new system which the Committee of the Society of American Bacteriologists has promulgated. The Committee does not regard the classification of species offered here as in any sense final, but merely a progress report leading to more satisfactory classification in the future.

The Committee desires to express its appreciation and thanks to those members of the society who gave valuable aid in the compilation of material and the classification of certain species. . . .

The assistance of all bacteriologists is earnestly solicited in the correction of possible errors in the text; in the collection of descriptions of all bacteria that may have been omitted from the text; in supplying more detailed descriptions of such organisms as are described incompletely; and in furnishing complete descriptions of new organisms that may be discovered, or in directing the attention of the Committee to publications of such newly described bacteria.

DAVID H. BERGEY, Chairman FRANCIS C. HARRISON ROBERT S. BREED BERNARD W. HAMMER FRANK M. HUNTOON Committee on Manual

August, 1923.



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#### INTRODUCTION

## Suggestions for the Use of the Manual in Classifying Unknown Organisms

No organism can be classified before we have determined, through detailed study, its morphological, cultural, physiological and pathogenic characters.

The characters used in the keys to orders, families and genera may ordinarily be determined by the use of a dozen or more of the procedures described in the Manual of Pure Culture Study issued by the Committee on Bacteriological Technic (H. J. Conn, Chairman, Geneva, New York) of the Society of American Bacteriologists. More complete examinations must be made as indicated in the Manual of Pure Culture Study, and in the Descriptive Charts which accompany this Manual where it is desired to identify individual species. These tests must be made if bacteria are to be accurately identified and described.

It is urged that beginning students be taught the technics necessary for the identification of species in the hope that the taxonomic work of the future may be placed on a more satisfactory basis.

After a complete study of the characters of the organism has been made, turn to page 65 and ascertain first in which order the organism belongs. When the order and suborder (if necessary) have been ascertained, turn to the page of the Manual on which the key to that order or suborder is given. In this key ascertain the family or subfamily to which the organism belongs.

When the family or subfamily has been decided on, again refer to the page of the Manual on which the key to that family or subfamily is given. In this key ascertain the tribe to which the organism belongs.

When the tribe has been decided on, again find the page of the MANUAL on which the key to the tribe is given. In this key ascertain the genus to which the organism belongs.

When the genus has been decided on, again refer to the page of the Manual on which the key to that genus is given. In this key, trace out the species under investigation

For example, if one wishes to trace a short, peritrichous, Gram-negative, non-spore-forming rod that grows well on ordinary culture media at 37°C, fermenting glucose and lactose with production of acid and gas, not liquefying gelatin, producing no pigment on any culture medium, with negative reaction for acetylmethylcarbinol, producing indole and reducing ultrates, consult the key to the orders on page 65.

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#### INTRODUCTION

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When the genus has been decided on, again refer to the page of the MANUAL on which the key to that genus is given. In this key, trace out

the species under investigation.

For example, if one wishes to trace a short, peritrichous, Gram-negative. non-spore-forming rod that grows well on ordinary culture media at 37°C. fermenting glucose and lactose with production of acid and gas, not liquefying gelatin, producing no pigment on any culture medium, with negative reaction for acetylmethylcarbinol, producing indole and reducing nitrates, consult the key to the orders on page 65.

In this key examine A. Cells rigid, not flexuous. This indicates our organism as its cells remain constant in form.

We next examine 1. Cells single, in chains or masses. Not branching and mycelial in character. Not arranged in filaments. Not acid fast. As the organism in question occurs as single cells or at most as short chains and is not acid fast, this indicates that it belongs to the Order Eubacteriales.

We now examine a. Do not possess photosynthetic pigments. Cells do not contain free sulfur. As our organism is unpigmented and the cells do not contain free sulfur, this indicates that our organism belongs to the Sub-order Eubacteriineae. We note that the key to this suborder is on page 67.

We next attempt to ascertain the family to which the organism belongs by tracing it through the key to the families of the Sub-order Eubacteriineae, p. 67.

I. No endospores indicates our organism. We proceed to A. Can develop on inorganic media. As the organism cannot grow without organic carbon, we turn to B. Cannot develop on inorganic media.

This corresponds with the physiology of our organism; so we turn to 1. Polar flagellate, etc. As our organism is peritrichous, we proceed to 2. Large out, pleomorphic cells sometimes almost yeast-like in appearance. Free living in soil. Fix free nitrogen. As this does not correspond with the morphology or physiology of our organism, we next examine 3. Peritrichous or non-motile rods, and cocci. This corresponds with the characteristics of our organism.

We turn to a. Heterotrophic rods which may not require organic nitrogen for growth. Usually mottle with one to six or more flagella. Usually form nodules or tubercles on roots of plants, or show violet chromogenesis.

This again does not indicate our organism; so we turn next to an. Heterotrophic rods or cocci which utilize organic nitrogen and usually carbohydrates. As our rod-shaped organism prefers a medium containing organic nitrogen, we proceed to b. Spherical cells in masses, tetrads and packets.

This does not correspond to the morphology of our organism, and we now proceed to bb. Spherical cells which grow in pairs and chains; and rods. This includes our rod-shaped organism; so we turn to c. Gram-positive cocci and rods. Non-motile. Since these are not the characteristics of our organism, we turn to cc. Gram-negative rods. When motile, from four to many pertrichous flagella.

Our organism is Gram-negative and peritrichous; so we proceed to d. Grow well on ordinary media containing peptone Aerobic to facultative angerobic.

This corresponds with the characteristics of the organism we have studied; so we turn next to e. Gram-negative, straight rods which ferment

sugars with the formation of organic acids. This again corresponds with our organism. We turn next to f. Produce title or no acid from litmus milk. This does not correspond with the characters we have determined for our organism. We proceed to ff Produce  $CO_2$  and frequently visible gas  $(CO_2 + H_3)$  from glucose. Reduce nitrates, etc

Our organism produces visible gas from glucose and reduces nitrates. This indicates that it belongs to Family X. Enterobacteriaceae, p. 443. This appears to fit our unknown organism. We now refer to page 443

This appears to it our unknown organism. We now refer to page 443 on which the key to the Family Enterobacteriaceae is found. In this key we ascertain the Tribe to which our organism belongs. 1. Ferment glucose and lactose with the formation of acid and visible gas. Usually do not liquefy gelatin Tribe I. Eschericheae.

This corresponds with the characters exhibited by our organism. We refer to the key for Tribe I. Escherichea on the same page. 1. Methyl red test positive. Voges-Proskauer test negative. Salls of citric acid may may not be used as sole source of carbon. Genus I. Escherichia, p. 444.

This description appears to correspond with that of our unknown organism. We find the key to the species of Genus Escherichia follows the key to the Tribe Escherichea. On tracing our organism in this key we find that it corresponds to Escherichia coli. A brief description of this organism is found on the same page.

\*In the use of keys for identifying bacteria, the student is confronted with two difficulties, both based primarily on lack of knowledge and experience. The first is insufficient knowledge concerning the morphology, physiology, possible pathogemeity and habitat of the microorganisms that are to be identified. This may be due to careless observations or to poor training in the special techniques that must be used in determining the identity of a given bacterium

The second difficulty in the use of a key comes from inexperience in the use of technical terms; that is, the student may not thoroughly understand the meaning of the statement in the key and so cannot follow a route through the key with certainty. For example in the keys used here, the student must know the difference (1) between chains of cells which are composed of dividing cells which do not separate at once, and (2) filaments which are composed of dividing cells which remain more permanently towhich are composed of dividing cells which remain more permanently together and are normally flattened against each other on adjacent sides. They may show some differentiation into hold fast cells and reproductive cells (conidia), (3) Both chains of cells and filaments are to be distinguished from the mycelial threads found in Actnomycetaccae. These are unseptate and branching with a true branching.

<sup>\*</sup>Condensed and paraphrased from Hatchcock's Descriptive Systematic Botany, New York, 1935.

The student should be warned not to take descriptions in the Manual too literally or too rigidly. Descriptions are usually drawn to represent average findings. Especially among bacteria, characters such as sugar fermentations, gelatin liquefaction, presence or absence of flagella and other things will vary. Sometimes these variations are due to slight, possibly unrecognized variations in the techniques used in determining these characters. Real knowledge of the characteristics of species may also be very incomplete. This is true not only of the physiological activities of these microorganisms; but also in regard to such detectable structural features as the number and position of flagella. Dark field movies of motile cells and photographs taken with the recently developed electron microscope are revealing new and heretofore unsuspected facts regarding structural features.

Source and habitat data are frequently helpful in aiding the student to recognize species of bacteria and may indicate that the pathogenicity of the culture in question may need to be tried on some specific animal or plant. By habitat is meant the kind of a place in which the organism normally grows; by source, the particular material and place from which the culture was obtained. Thus source may or may not indicate the natural habitat. The source of cultures is invariably more limited in scope than the habitat as bacteria normally occur wherever their particular habitat may be found in a world wide distribution.

The student is also reminded that it is impracticable to note all exceptions in keys. Bacteria like other living things are classified according to a combination of characters, not according to some single character, and exceptions to the characters noted in the keys will occur in nature. These may not be known to or may have been overlooked by the author of the key. On the other hand, the importance of such exceptions should not be overemphasized and the student would do well to use the key as if there were no exceptions.

## HISTORICAL SURVEY OF CLASSIFICATIONS OF BACTERIA, WITH EMPHASIS ON OUTLINES PROPOSED SINCE 1923\*

There have been numerous attempts to arrange the species of bacteria in natural systems of classification. The first simple system of Muller (Vernium terrestrium et fluviatilium, 1773) which he developed further a few years later (Animalcula infusoria fluviatilia et marina, 1786) listed but two genera (Vibrio and Monas) that included organisms that would today probably be accepted as bacteria. Polyangum Link (Mag d. Ges. Naturforsch. Freunde zu Berlin, 3, 1809, 42) is apparently the oldest of the generic terms retained in its original meaning for a bacterial genus while Serratia Bizio (Biblioteca italiana o sin giornale de lettera, scienze ed arti, 30, 1823, 288) was proposed only fourteen years later.

Systems of classification developed after 1773 are given in complete outline form in the first edition of the Manual (1923) and this section of the Manual was reprinted without material change in the second (1925) and third (1930) editions. While it is not felt to be necessary to repeat these outlines in their entirety, sufficient reference is made below to permit the student to trace the origin of generic terms that are no longer commonly found in classification outlines. No attempt has been made to include reference to other little used generic terms except as they appear as synonyms in the descriptive portion of the Manual. For the origin of generic terms proposed before 1925, see Enlows (The Generic Names of Bacteria, Bul. No. 121, Hygienic Laboratory, Washington, D. C., 1920) and Buchanan (General Systematic Bacterology, Baltimore, 1925).

Bory St. Vincent (Microscopiques, Dictionnaire classique d'histoire naturelle, 10, 1826, 533) introduced the generic terms Spirilina, Melanella, Lactrimatoria and Pupella and accepted Vibro for microorganisms, some of which must have been bacteria. None of these terms, except Vibro, are in current use for bacterial groups.

Three of the terms accepted or proposed by Ehrenberg (Die Infusionstierchen als volkommene Organismen, Leipzig, 1838); namely, Vibrio, Spirillum and Spirochaeta, are still used The generic term Bacterium proposed first by Ehrenberg in 1828 (Symbolae Physicae seu Icones et Descriptiones Animalium Evertebratorum Separasitis Insectis quae ex Itinere per Africam Borealem et Asiam Occidentalem, IV. Evertebrata, Berlin) to include but a single species Bacterium triloculare from an oasis

<sup>\*</sup>Contributed by Prof. R. S. Breed, New York State Experiment Station, Geneva, New York, July, 1938; revised, September, 1943.

11th Ann. Rept., 1899, 36), or in his complete outline (Manual Determ. Bact., 1901). Almost all of the generic terms found in his outlines are still in current use.

The term Aplanobacter suggested by Erwin F. Smith (Bacteria in Relation to Plant Diseases, 1, 1905, 171, Washington) was accepted by certain American phytopathologists for a time but has never come into general use.

Because other differences between the non-chromogenic and chromogenic micrococci are unimportant, two generic terms, Albococcus and Aurococcus, suggested by the Winslows (Science, 21, 1905, 669; Systematic Relationships of the Coccaccae, New York, 1908) have not come into general use. They also suggested Rhodococcus to include Rhodococcus roseus and R. fulvus apparently without realizing that Zopf (Ber. d. deutsch. bot. Gesellsch. Berlin, 9, 1891, 28) had previously used the same term for Rhodococcus crythromyxa and R. rhodochrous. Hansgirg (Engler and Prantl, Die naturlichen Pflanzenfamilien, 1, 1a, 1895, 52) had also used it previously to designate a sub-genus of the green algae, and later Molisch (Die Purpurbakterien, Jena, 1907, 20) used Rhodococcus for a genus of the purple bacteria to include Rhodococcus capsulatus.

In his complete outline of the classification of bacteria presented in 1909, Orla-Jensen (Cent. f. Bakt., II Abt., 22, 1909, 305) introduced many new generic terms in an effort to create a nomenclature that appeared to him to express the natural relationships of bacteria more satisfactorily than names previously suggested had done. Thus he used the suffixes coccus and sarcina for spherical bacteria and monas for all genera known to be lophortrichous or so related to these types that they were regarded as essentially lophotrichous in nature. In the same way the suffix bacterium was used for genera of non-spore-forming rods that were regarded as essentially peritrichous in nature, and the suffix bacillus for similar spore-forming rods. As, however, subsequent investigators have (1) accepted the priority rule, (2) felt that it was impossible to recognize the type of motility found in the ancestry of truly non-motile groups, or (3) felt that other characters were more fundamental than those selected by Orla-Jensen, many of these terms have not been generally used by later workers.

Among the little used terms suggested or accepted by Orla-Jensen are: Acetimonas, Natromonas, Azotomonas, Rhizomonas, Corynemonas, Mycomonas, Sulfomonas, Thiomonas, Thococcus, Rhodomonas, Rhododictyon, Amoebomonas, Rhodopolycoccus, Rhodosarcina, Spirophyllum, Denitromonas, Liquidomonas, Laquidovibrio, Liquidococcus, Solidococcus, Solidovibrio, Sporosarcina, Dentrobacterium, Caseobacterium, Liquidobacterium, Urobacillus, Butyribacillus, Pectobacillus, Cellulobacillus, Putribacillus and Rotulobacillus.

While Nitromonas is not new, it is redefined as a synonym of Nitrobacter Winogradsky (Arch. Sci. Biol. St. Petersburg, 1, 1892, 87), rather than as a synonym of Nitromonas Winogradsky (Ann. Inst. Past., 3, 1890, 258). Spirophyllum is from Ellis (Cent. f. Bakt., II Abt., 19, 1907, 507).

In a later monograph on The Lactic Acid Bacteria (Mém. d. Acad. Roy. Sci. et Lettres de Danemark, Sect. Sci., 8 Sér., 5, 1919, No. 2) Orla-Jensen proposes the following additional generic terms: Belacoccus, Belabacterium, Streptobacterium, Thermobacterium and Microbacterium. The term Tetracoccus is introduced with a meaning different from that given the term previously by v. Klecki (Cent. f. Bakt., 15, 1894, 354).

Buchanan prepared an outline classification in 1916 (Jour. Bact., 1, 1916, 591; 2, 1917, 155, 347, 603, 3, 1918, 27, 175, 301, 403, 401, 591) which was utilized in part by the group of which he was a member (Winslow, Broadhurst, Buchanan, Krumwiede and Smith) in their preliminary Report to the Society of American Bacteriologists (Jour. Bact., 2, 1917, 552) and in the final report by Winslow, Broadhurst, Buchanan, Krumwiede, Rogers and Smith (Jour. Bact., 4, 1920, 191).

Although prepared earlier, some parts of the Buchanan outline were not published until after the first Winslow et al. report. As these reports formed the most important basis for the classification used in the first edition of the Manual, it is natural that the generic terms utilized are, in general, the same as those used in the Manual.

Generic and subgeneric terms included by Buchanan that are not used in the present edition of the MANUAL are: Paraspirillum Dobell (Arch. f. Protistenk., 24, 1911, 97), Eubacillus Hansgirg (Osterr. Bot. Ztschr., 38, 1888, 264; not Eubacillus Dangeard, Le Botaniste, 2, 1891, 151) and Melabacterium Chatton and Perard (Comp. rend. Soc. Biol , Paris, 65, 1913, 1232). Siderocapsa Molisch (Ann. Jard. Bot. Buitenzorg, Ser. 2, Supp. 3, 1909, 29) used by Buchanan but dropped by Winslow et al (Jour. Bact., 2, 1917, 549) does not appear in the Manual classification outline until the Present (6th) edition. The term Mycoderma recognized both by Buchanan (Jour. Bact., 3, 1918, 45) and in the preliminary Winslow et al. report (Jour. Bact., 2, 1917, 551) was replaced by the later and more valid term Acetobacter in the final report by Winslow et al. (Jour. Bact., 5, 1920, 201). Pfeifferella Buchanan (Jour. Bact., 3, 1918, 51) which is used in the three outline classifications under discussion and also in the first, second and third editions of the Manual, appeared in the literature through a clerical error (Buchanan, General Systematic Bacteriology, 1925, 420). It was combined in the fourth edition of the MANUAL with the genus Actinobacillus under the latter name. Nocardia Trevisan (1889) u-cd by Buchanan and in the preliminary report by Winslow et al. (1917) was merged with Actinomyces

Harz (Jahresber. Munchen. Thierarzneisch. for 1877–78, 125) in the final report by Winslow et al. Erythrobacillus Fortineau (Compt. rend. Soc. Biol. Paris, 58, 1905, 104) is used by Winslow et al. (1920) but was not accepted in the first and following editions of the Manual as it is a synonym of the older Serratia Bizio (1823). Moreover, the species which must be accepted as type for the genus (Erythrobacillus pyosepticus Fortineau (monotypy)) is a species which has been reported by Breed (Manual, 3rd ed., 1930, 117) to be a variant of the older Serratia marcescens.

One of the most unsatisfactory portions of recent classifications, such as those outlined by Buchanan (1917–18) and by Winslow et al. (1917), is the treatment given the organisms of the coliform-dysentery-typhoid group in that the term Bacterium is retained for these as suggested by Orla-Jensen (1909). A strict limitation of Bacterium to this group gives it a still different meaning from that which it had had in previous and current classifications, and makes it necessary to find some other place for many other species of Gram-negative, non-spore-forming rods, some of which are well known and well described. The relationships of these miscellaneous species to other non-spore-forming rods is frequently poorly understood. In some cases, further study will probably show that they should be placed in well known and currently recognized genera. In others, further study will probably show that some of these species of non-spore-forming rods should be grouped in new genera.

Winslow et al. (1920) recognized this situation and broadened their definition of Bacterium thereby placing such well known species as are included in the colon-dysentery-typhoid group with other species of non-spore-forming rods of quite a different character. For this reason, partial use was made in the first edition of the Manual of the numerous generic terms newly proposed by Castellani and Chalmers (Manual of Tropical Medicine, 3rd ed., 1919) Thus the following new terms were introduced: Alcaligenes, Salmonella, Escherichia and Encapsulatus; and the earlier terms Aerobacter Beijerinck (1900) and Eberthella Buchanan (1918). Later it was found that Encapsulatus was a synonym of Klebsiella Trevisan (1887), so that the latter term was accepted in the second and subsequent editions of the Manual in the third and subsequent editions.

Many of the new terms suggested by Castellani and Chalmers were, however, synonyms of earlier valid terms or have not been considered necessary, and so they have not come into general use. These are Niprococcus, Graciloides, Cloaca, Eberthus, Dysenteroides, Lankoides, Wesenbergue Balkanella and Enteroides. No new generic terms are given by Castellani and Chalmers in their later report (Ann. Inst. Past., 34, 1920, 600).

Orla-Jensen (Jour. Bact., 6, 1921, 263), in a paper published after the manuscript of the first edition of the Manual was prepared, suggested the use of Colibacterium and Aerogenesbacterium for the two genera in the coliform group and adds quite a number of other new terms formed in accordance with his system of nomenclature. These are, in most cases, synonyms of earlier valid names. The new terms are Coccomonas, Spiromonas (used in a new, different sense from that of earlier authors), Fluoromonas, Photomonas, Propionicoccus, Buturiclostridium and Putriclostridium.

Many new terms are proposed in the classification drawn up by Heller (Jour. Bact., 6, 1921, 521; and 7, 1922, 1). Details are given in the group of anaerobic spore-formers only. Here each of the new generic terms is based on a single species The following outline is given in the first of these papers, two new genera (Rwoltillus and Metchnikovillus) being made the type genera for two new subfamilies Clostradioideae and Putrificoideae, respectively.

respectively.

Phylum I. Bacteria
Class I. Eubacteriaes
Order 1 Eubacteriales
Family 6 (?). Clostridiaceae
Subfamily 1. Clostridioideae
Subfamily 2. Putrificoideae
Order 2 Thobacteriales
Order 3. Chlamydobacteriales
Class II. Myzobacteriaes

In the more complete outline in the second paper, one generic term (Clostridium) is old, although it is used in a new and restricted sense, while with the exception of the type genera mentioned above, the other terms are new. In the subfamily Clostradioideae, the new terms are Omelianskillus, Macintoshillus, Douglasillus, Henrillus, Flemingillus, Vallorillus, Multifermentans, Hiblerillus, Welchillus, Stoddardillus, Arloingillus, Meyerillus and Novillus. Ten new generic terms are used in the subfamily Putrificoideae as follows: Sequinillus, Reglillus, Robertsonillus, Nicolaierillus, Martellillus, Recordillus, Tissierillus, Putrificus, Ermengemillus, and Weinbergillus. As there does not seem to be any good reason for sub-dividing the genus Clostridium in this way, the latter term has been used to cover anaerobic spore-forming rods in all previous editions of the Manual, and is again used in the present edition in this sense rather than with the restricted meaning proposed by Heller.

Enderlein (Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 309) proposed an outline classification covering the Kingdom of Mychota, or bacteria, which was based on comparative morphology with special emphasis on life

cycles. This was as follows:

Phylum I. Dimychota

Kreis A. Holocyclomorpha Class I. Gonascota

Order a. Synascota

Family 1. Schaudinnidae

Genus a. Schaudinnum

b. Theciobactrum

Family 2. Sphaerotilidae Genus a. Phragmidiothrix

b. Newskia

c. Chlamydothrix

d. Sphaerotilus

e. Clonothrix Family 3. Syncrotidae

Genus B. Crenothrix

b. Beggiatoa

c. Suncrotis

d. Zygostasis

Family 4. Spirillidae

Genus a. Gallionella

b. Spirillum

c. Dicrospirillum

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Family 5. Spirochaetidae

Genus a. Cristispira

b. Treponema

c. Entomospira

d. Spirochaeta

e. Cacospira Family 6. Microspiridae

Genus a. Spirobacillus

b. Spirosoma

e. Photobacterium

d. Microspira

e. Dicrospira

Family 7. Cormobacteriidae Subfamily 1. Actinomycinae

Genus a Actanomuces

Subfamily 2. Eisenberginge Genus a. Eisenbergia

Subfamily 3 Sclerotrichinge

Genus n. Zettnowia b. Schlerothrix

Subfamily 4. Corynobacteriinae

Genus a. Corunobacterium

b. Heterocystia

c. Cladascus

d. Zygoplagia

Subfamily 5. Pseudostrepinas Genus a. Pseudostreptus

Order b. Ascola

Family 8. Bacteriidae

Genus a. Atremis

b. Bacterium c. Lamprella

d. Eucustra e. Dicrobactrum

f. Acustia

Family 9. Fusiformidae

Genus a. Fusiformis

Class II Sporascota

Order a Parasynascota Family 10. Migulanidae

Genus a. Migulanum Order b. Parascota

Family 11 Bacillidae

Genus a. Rhagadascia

b. Plectridium e Racellus

d. Bactrillum

e. Kochella

Fischerinum

Kreis B Hemicyclomorpha Class I. Anascota

Family 12 Hemallosidae Genus a Hemallosis

Phylum II. Monomychota

Acyclomorpha Kreis A

Tamily 1. Mogallidae Genus a. Mogallia

Family 2 Sarcinidae

Genus a. Diplococcus

h. Sarcina

c. Paulosarcina

Family 3. Micrococcidae Genus a. Micrococcus

b. Planococcus c Streptococcus

Phacelium

Three of the new generic terms, Cladascus type species C. furcabilis Enderlein, Zygoplagia type species Z. alternans Enderlein and Heterocystia type species H. multiformus Enderlein, had been proposed in an earlier paper (Sitzber, Gesell, Naturf, Freunde, Berlin, 1916, 395). The following generic terms in the 1917 outline are new: Schaudinnum, Theciobactrum, Syncrotis, Zygostasis, Dicrospirillum, Entomospira, Cacospira, Dicrospira, Eisenbergia, Zettnowia, Pseudostreptus, Atremis, Lamprella, Eucystia, Dicrobactrum, Acystia, Migulanum, Rhagadascia, Kochella, Fischerinum, Hemallosis, Mogallia, Paulosarcina and Phacelium. Note that Corynobacterium is spelled with an o instead of an e.

Terms accepted from earlier workers that have not previously been

mentioned are: Spirobacillus Metschnikoff (Ann. Inst. Past., 3, 1889, 62), Photobacterium Beijerinck, Maanblad voor Natuurwetenschappen Amsterdam, 16, 1889, 1 and Arch. Neérl. d. Sci. Exactes, 23, 1889, 401), and Sclerothrix Metschnikoff (Arch. f. Path. Anat. u. Physiol., 113, 1888, 63-94; not Sclerothrix Kuetzing, Species Algarum, 1849, 319).

The above outline was changed in 1925, p. 235 ff. (Bakterien-Cyclogenie, Berlin, 390 pp.) by the addition of one new family, Chondromycidae, to include the genus Newskia, formerly included in Sphaerotilidae, and nine genera not previously given as follows: Chondromyces, Cystodesmia, Monocystia, Ophiocystia, Apelmocoena, Polyangium, Cystocemia, Myxococcus and Dactylocoena. All except Chondromyces, Polyangium and Myxococcus are taken from Enderlein (Bemerkungen zur Systematik der Chondromyciden, Berlin, 1924, 6 pp.).

The new genus Lohnisium is added in the Family Eisenbergiinae to include the acetic acid and legume bacteria, and he also proposes the generic term Macrocystita (p. 278) for certain bacteria described by Peklo (O mšici krváve (Study of the blood louse). Zemědelského Archivu (Agricultural Archives), 1, 1916) from aphids. According to Enderlein it is not clear whether this genus should be included in the Family Bacteriidae or in Corynobacteriidae.

Two genera proposed by others are also accepted. These are Calymmatobacterium Aragão and Vianna (Mem. Inst. Oswaldo Cruz, 6, 1912, 211) placed in the family Migulanidae, and Leuconostoc Van Tieghem placed in the family Micrococcidae.

Later Enderlein (Sitzber. Gesell. Naturf. Freunde Berlin, 1930, 104-105) accepts Serratia Bizio in place of Dicrobactrum and Leplotrichia Trevisan in place of Syncrotis. Streptus with Streptus scarlatinae as type species, is proposed to cover the streptococci not included in Pseudostreptus.

The outline suggested by Pringsheim (Lotos, 71, 1923, 357) is similar to that used by Lehmann and Neumann (Atlas und Grundriss der Bakteriologie, 2 vols, 1896, München). It is a conventional division into spherical, rod-shaped and curved forms so far as the true bacteria are concerned except that the pseudomonads are included in the same family as the vibrios and spirilla. Rhodobacteriales is recognized as an order to include the sulfur purple bacteria and the nonsulfur purple bacteria. Few details are given in regard to the other orders. His outline follows:

#### Schizomycetes

Order I. Eubacteriales Family 1. Coccaceae

Genus a Streptococcus

- b. Micrococcus
- c. Sarcina

Family 2. Bacteriaceae Genus a. Bacterium b. Bacillus

Family 3 Spirillaceae Genus a Pseudomonas

b Vibrio

c Spirillum Order II Rhodobacteriales

Family 1 Rhodobacterinae

2 Thiorhodinae

Order III Myxobacteriales

Family 1 Myxobacteriaceae

Order IV. Mycobacteriales

Family 1 Corynebacteriaceae
2. Mucobacteriaceae

3. Actinomycelaceae

(Also possibly the long rod, lactic acid bacteria )

Order V Desmobacteriales

Family 1 Chlamydobacteriaceae
2 Beggnatoaceae

The first outline classification drawn up by Janke (Allgemeine Technische Mikrobiologie, I Teil, Dresden, 1924, p. 63) is an adaptation and expansion of that drawn up by Migula (System der Bakterien, 1900). The new genera recognized by Janke are Planostreptococcus A. Meyer (Die Zelle der Bakterien, Jena, 1912), Thiopioca Lauterborn (Ber. dtsch. Bot. Gesell., 25, 1907, 238), Thiobacterium Molisch (Cent. f. Bakt., II Abt., 33, 1912, 55), Thiobactilus Beijerinck (Cent. f. Bakt., II Abt., 11, 1904, 593), Thiovibrio Janke (loc. cit.), Thio-printlum Winogradsky (Beitrage zu Morphol. u. Physiol. d. Bakterien. Heft I. Schwefelbakterien. Leipzig, 1888), Thio-spharella Nadson (Bull. Jar. bot Petersburg, 13, 1913, 106; ref. in Cent. f. Bakt., II Abt., 43, 1915, 469), Thiovulum Hintze (Ber. Dtsch. Bot. Gesell., 31, 1913, 189), Spirophyllum Ellis (Proc. Roy. Soc. Edinburgh, 27, 1, 1907, 21; ref. in Cent. f. Bakt., II Abt., 26, 1910, 321), and Actinococcus Beijerinck (Fol. Microbiol. 2, 1914, 185)

Janke's outline classification is given below:

Order I. Lubacteria

Family 1. Coccaceae

Genus a. Streptococcus

c. Sarcina

d. Planosireptococcus

e Planococcus f. Planosarcina

Family 2. Bacteriaceae Genus a. Bacillus

B. Bacterium

Family 3. Spirillaceae

Genus a. Microspira

b. Spirillum

e. Spirosoma

Order II. Rhodobacteria Family 1. Thiorhodaceae

Subfamily 1a. Thiorysteae

Genus a. Thiocystis

b Thiocapsa

c. Thiosphaera

d. Thiosphaerion

e. Thiosarcina

Subfamily 2b. Lamprocysteae
Genus a. Lamprocystis

Subfamily 3c. Thropedicae

Genus a. Thiopedia
b. Thioderma

Subfamily 4d. Amoebobacterieae

Genus a. Amoebobacter b. Thiothece

c. Thiodictyon

d. Thiopolycoccus

Subfamily 5e. Chromaticae Genus a. Chromatium

b. Rhabdochromatium

c. Thiorhodospirillum

Subfamily 6f. Rhodocapseae

Genus a. Rhodocapseae

b. Rhodothece

Family 2. Athiorhodaceae Subfamily 1a Rhodocysteae

Genus a. Rhodocystis

b. Rhodonostoc

c. Rhodococcus

d Rhodobacterium

e. Rhodobacillus

f. Rhodoribrio

g. Rhodospirillum

Order III. Thiobacteria

Family 1 Beggiatoaceae

Genus a. Thiothrix b. Beggiatoa

b. Beggiatoa c. Thioploca

Family 2. Thiobacteriaceae

Genus a. Thiophysa

b. Thiobacterium

c Thiobacillus

d. Thioribrio

e. Thiospirillum f Thiosphaerella

g. Thiovulum

h. Achromatium

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Order IV. Phycobacteria
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Genus a Leptothriz

h. Clanathrin

e Cladathria

d Crenothrix

e. Phragmidiothrix

Appendix Genera Gallionella, Spirophyllum, Nodofolium Order V. Mucobacteria

Family 1. Mycobacteriaceae

Genus a Corynebacterium

b Mycobacterium

Family 2. Actinomycetaceae Genus a. Actinomyces

b. Actinococcus

Order VI. Myzobacteria Family 1, Myxobacteriaceae

Genus a. Myzococcus

h. Chondromyces

c Polyanguum

Lehmann and Neumann (Bakt Diag., 2 vols , 7th ed , Munchen, 1926-27; Breed, Eng. trans., New York, 1931) developed their first simple and much used outline classification, drawn up in 1896, in later editions of their Determinative Bacteriology. The 1927 Lehmann and Neumann outline is as follows:

# Class I. Schizomycetes

Order I Schizomycetales

Family 1. Coccaceae

Genus a Streptococcus

h Sarcing

e. Micrococcus Sub-genus a Diplococcus

h (Gram-positive group)

Family 2. Bacteriaceae

Genus n. Baclerium

Sub-genus a Nitrosomonas

b Nutrobacter

c. Rhizobium d Haemophilus

e Brucella

f. Pasteurella

g (Glanders and dysentery group)

h. (Photogenic group)

1 (Aerogenes group)

j. Encapsulatus

k. (T) phoid group)\*

1 Salmonella

m. (Coli group)\*

In a footnote under these groups, the authors refer to the names given by Castellani and Chalmers.

n. Acetohacterium

o. (Cloacae group)

p. (Red chromogens)

q. (Blue and violet chromogens)

r. Pseudomonas

s. Proteus

App. Erusipelothrix

Genus b. Fusobacterium

c. Plocamobacterium

Family 3. Desmobacteriaceae

G nus a. Beggiatoa

b. Leptothrix

Sub-genus a. Leptothrix

b. Chlamudothrix

Genus c. Crenothrix

d. Cladotheir

e. Thiothrix

Family 4. Spirillaceae Genus a. Vibrio

b. Spirillum

Family 5. Spirochaetaceae

Genus a. Spirochaeta

Family 6. Bacillaceae

Genus a. Bacillus

Sub-genus a. (Aerobic group)

b. (Anacrobic group)

Order II. Actinomycetales

Family 1. Proactinomucetaceae Genus a. Corunebacterium

b. Mycobacterium

Family 2. Actinomycetaceae

Genus a Actinomyces

The generic term Bacterium is retained in this outline to cover those groups of the true bacteria that are Gram-negative, non-spore-forming, motile and non-motile rods. Lehmann and Neumann recognize 20 subgroups in this genus, many of which correspond with the genera recognized in the Manual. In an effort to develop a rational nomenclature the term Acetobacterium (occurs first in review by Ludwig, Cent. f. Bakt., II Abt., 4, 1898, 870) is used in place of Acetobacter, Plocamobacterium (Loewi, Wien. klin. Wchnschr., 33, 1920, 730) in place of Lactobacillus, and Fusobacterium (Knorr, Cent. f. Bakt., I Abt., Orig., 89, 1922, 4) in place of Fusiformis without regard to priority. Encapsulatus Castellani and Chalmers (Manual Tropical Med., 3rd ed., 1919, 934) is used in place of Klebsiella Trevisan (Atti Accad. Fis.-Med.-Stat. Milano, Ser. 4, 3, 1885, 107).

Janke (Cent. f. Bakt., II Abt., 66, 1926, 481) reprints the classification developed in the first edition of the present Manual and compares it with that proposed by Orla-Jensen and Enderlein.

The second complete outline drawn up by Janke (Oesterr. Bot. Zeitschr., 78, 1929, 108) is similar to the classification employed by Lehmann and Neumann (Bakt. Diag., 2 vols., 7th ed., Munchen, 1926–27). He follows Enderlein in placing deotobacter in close association with the spore-forming rods. No new generic terms are suggested. His sub-groups of the genus Bacterium are even more closely similar to the genera used in the present edition of the Manuat than are the sub-groups of Lehmann and Neumann.

Family 1. Coccaceae

Genus a. Micrococcus

h Neisseria

c. Streptococcus

Divided into 4 groups.

d. Sarcina

Divided into 2 groups.

Family 2. Bacillaceae

Genus a. Bacillus

Divided into 16 groups

b. Azotobacter Family 3. Bacteriaceae

Genus a. Bacterium

Divided into 27 groups

b Fusiformis

Family 4. Corynobacteriaceae

Genus a. Mycobacterium

b Corynobacterium

e Actinomyces

Family 5. Spirillaceae

Genus a. Microspira
Divided into 2 groups.

b. Spirillum

Divided into 2 groups,

Family 6. Spirochaetaceae

Genus a. Spirochaeta

b. Borrelia

c. Treponema d. Cristispira

e. Saprospira

f. Leptospira

Family 7. Desmobacteriaceae

Genus a. Beggiatoa

b. Thioploca

c. Thiothrix

d. Leptotrichia

e. Crenothrix

g. Clonothriz

h. Leptothriz

i. Phragmidiothriz

Family 8 Myzobacteriaceae
Genus a. Myzococcus
b. Polyangium
c. Chondromyces

Pribram (Jour. Bact., 18, 1929, 361) has rearranged some groups and combined others (e.g., Rhizobium, Diplococcus, Leuconostoc, Serratia, Flavobacterium, Chromobacterium, Achromobacter, Cellulomonas) recognized in the first edition of the Manual with little change in the nomenclature except among the anaerobic non-spore-forming rods and among the spore-forming rods. Unfortunately, he has sometimes used family and species names as generic names, thus in the latter case introducing adjectives and adjectival terms as substantives. New generic terms suggested are: Dialisterea, Bacteroidea, Centrosporus, Fusibacillus, Pseudobacillus, Megatherium, Flexus, Anthrax, Botulinus, Chauvoea, Botulinea, Putrificus, Welchia, Phleobacterium, Distasoa, Tissicria, and Actinoidomyces. Astasia as it appears in this outline does not appear to be the same as Astasia Meyer (Flora, 84, 1897, 185). Aerobacillus is not synonymous with Aerobacillus Donker (Inaug. Diss., Delft, 1926). Sideromonas is accepted from Cholodny (Ber. Deutsch. Bot. Ges., 40, 1922, 326).

Pribram's complete outline follows:

Class Schizomycetes Subclass A. Protozoobacteria Order I. Spirochaetales Family 1. Spirochaetaceae Genus a Spirochaeta b. Treponema c. Spironema Family 2. Cristispiraceae Genus a. Saprospira b Cristispira e. Leptospira Subclass B Eubacteria Order I. Protobacteriales Family 1. Natrobacteriaceae Related to Pseudomonas Tribe A. Hydrogenomonadae Genus a. Hydrogenamonas b. Methanomonas c. Carhozuodomonas Tribe B. Nitrobactereae Genus a. Nitrosomonas b Nitrobacter Family 2. Thiobacillaceae Tribe A. Thiobacilleae Genus a. Thiobacillus

Order II. Metabacteriales

Family 1. Pseudomonadaceae

Tribe A. Spirilleae

Genus a. Spirillum

Tribe B. Vibrioneae

Genus a. Vibrio Tribe C. Pseudomonadeae

Genus a Pseudomonageae

b. Azotobacter

Connects with Polyangiaceae and Nitrobacteriaceae

Family 2. Bacteriaceae

Tribe A. Aerobactereae

Genus a. Aerolacter

b. Escherichia

c. Salmonella

d. Eberthella

e. Proteus Tribe B. Pasteurelleae

Genus n. Alcaligenes

h. Pasteurella

Connects with PfeisTerella

c. Hemophilus

Connects with Dialister

Family 3 Micrococcaccae

Tribe A. Streptococceae

Genus a. Neisseria b. Streptococcus

Tribe B. Macrococceas

Genus a. Micrococcus

b. Staphylococcus

c. Sarcina

Connects with Algobacteria

Subclass C. Mycobacteria

Order I. Bacteriomycetales

Pamily 1 Leptotrichaceae

Tribe A. Acetobactereae

Genus a. Acetobacter

Connects with Salmonella and Tissieria

Tribe B Leptotricheae

Genus a. Kurthia

b. Lactobacillus

Connects with Corunebacterium

e. Leptotrichia

Connects with Erusipelothrix

Pamily 2. Bacteroidaceae

Tribe A. Dialistercae

Genus a. Type species Dialisterea variegata
Connects with Distasoa

b --- Type species Diglisterea sariabilis

c. Dialister

Connects with Hemophilus

Tribe B. Bacteroideae

Genus a. Type species Bacteroidea multiformis b. Bacteroides

Connects with Tissieria

c. - Type species Bacteroidea fusiformis

Order II. Bacillomycetales

Family 1. Bacillaceae

Sub-family 1a. Aerobacilloideae

Tribe A. Aerobacilleae

Sub-tribe A1. Centrosporineae

Genus a. Centrosporus

b. Fusibacillus

Sub-tribe A2. Aerobacillineae

Genus a. Aerobacillus

Tribe B. Pseudobacilleae

Genus a. Pseudobacillus

Sub-family 1b. Bacilloideae Tribe A. Bacillege

Sub-tribe Al. Bacillineae

Genus a. Bacillus

b. Megatherium

Sub-tribe A2. Astasineae Genus a. Astasia

b. Flexus

Tribe B. Anthraceae

Genus a. Anthrax

Family 2. Clostridiaceae Sub-family 2a. Botulinoideae

Tribe A. Botulineae

Genus a. Botulinus

b. Chauvoea

c. Type species Botulinea saccharolytica d. ---- Type species Botulinea butyrica

Tribe B. Putrificege

Genus a. Putrificus

Sub-family 2b. Clostridioidege

Tribe A. Welchiege

Genus a. Welchia

Tribe B. Clostridicae Genus a. Clostridium

Order III. Actinomycetales

Family 1. Mycobacteriaceae

Tribe A. Actinobacilleae Genus a. Pfeifferella

Connects with Pasteurella

b. Actinobacillus

c. Corynebacterium d. Erusipelothrix

Connects with Leptotrichia

Tribe B. Mucobactereae

Genus a. Phleobacterium

Mycobacterium

Tribe C. Tissierieae Genus a. Distasoa

b. Tissieria

Connects with Bacteroides, Corynebacterium and Acetobacter Family 2. Actinomycetaceae

Tribe A. Actinoidomycetaceae

Genus a. Actinoidomyces

Tribe B. Actinomycetaceae Genus a. Actinomyces

Subclass D. Algobacteria

Order I. Desmobacteriales

Family 1. Sphaerotilaceae Genus a. Sphaerotilus

Order II. Siderobacteriales

Family 1. Chlamydotrichaceae Tribe A. Chlamydotricheae

> Genus a. Leptothriz b Crenothriz

Family 2. Siderocapsaceae

Genus a. Didymoheliz

b. Siderocapsa

c. Sideromonas

Order III. Thiobacteriales
Family 1. Rhodobacteriaceae

Sub-family 1a. Chromatoideae Tribe A. Thiocapseae

Genus a. Thiocystis

b Thiosphaera

c. Thiosphaerion

d. Thiocapsa

e. Thiosarcina

1. Lamprocystis

Tribe B. Thiopedicae Genus a. Lampropedia

b. Thioderma

Tribe C. Amoebobacteriae

Genus a. Amoebobacter

b. Thiodictyon

c. Thiothece

d. Thiopolycoccus
Tribe D. Chromaticae

Genus a. Chromatium

b. Rhabdomonas

c. Thiospirillum

d. Rhodocapsa

e. Rhodothece

Sub-family 1b. Rhodobacteroideae Tribe A. Rhodobacteriaceae

Genus a. Rhodobacterium

Genus a. Rhodobacteriun

c. Rhodonibrio

d. Rhodospirillum

e. Rhodosphacra

Tribe B. Rhodocysteae
Genus a. Rhodocystis

Genus a. Rhodocystis b. Rhodonostoc

Connects with Leuconostae

Family 2 Regardonceae

Family 2 Beggiatoaceae Genus a. Thiothrix

b. Benniatoa

c. Thioploca

c. Thiopioca Family 3. Achromatiaceae

Genus a. Achrematium

b. Thiophusa

c. Thiospira

d. Hillhousia

Order IV. Muzobacteriales

Family 1. Polyangiaceae

Genus a. Chondromyces

b. Polyangium

Family 2. Myxococcaceae

mily 2. Myxococcaceae Genus a. Myxococcus

Later Pribram (Klassification der Schizomyceten (Bakterien), Leipzig and Wien, 1933, 143 pp.) developed this classification into a suggestive outline based on his experience in caring for the cultures of the Kral Collection. His most interesting contribution is the separation of the class of Schizomucetes into three subclasses which are based on differences in fundamental biological and nutritional relationships. The fourth sub-class of his earlier outline (the Protozoobacteria with its single order Spirochaetales) is omitted from this outline. The first class, Algobacteria, includes the bacteria that are primarily free living in water, usually motile with polar flagellation and live on easily soluble foodstuffs. They are frequently surrounded by insoluble secretions such as capsules, sheaths, etc., and form insoluble products in their protoplasm, such as calcium, sulfur and iron compounds, and pigments. The class Eubacteria includes those bacteria whose normal habitat is the animal body or complex waste products of plant or animal origin. Because of adaptation to environment, these organisms are motile or non-motile and can utilize compounds of complex molecular structure. The third sub-class, Mycobacteria, is adapted to life in soil, and shows a distinct tendency to differentiation in morphology and spore formation.

Internationally accepted rules of nomenclature are generally followed, and the generic terms proposed in his earlier outline that were not formed

in accordance with recommended practices are discarded. He has revived Ulving Kútzing, 1837 (status explained by Buchanan, General Systematic Bacteriology, 1925, p. 518) in place of Acetobacter Beijerinck and accepted Plocamobacterium (Loewi, Wien klin. Wehschr., \$3, 1920, 730) in place of Lactobacillus Beijerinck, 1901. Among the spore-forming rods, he has accepted Bactrillum Fischer and Welchillus Heller, 1921. Malleomyces Hallier (Bot. Ztg., 24, 1866, 383) is used for the glanders bacillus. Anthracillus is apparently new.

The new outline has the following form:

## Class Schizomycetes

Subclass A. Algobacteria

Order 1. Micrococcales Family 1 Micrococcaceae

Genus a. Micrococcus

b. Rhodococcus

c. Rhodocapsa

d. Thiocapsa

e Thiosphaera f. Throsphaerion

g. Thiocystis h Lamprocystis

Sareina

Throsarcina

Pamily 2 Pediococcaceae Genus a Pediococcus

b. Lampropedia

c. Thiothece

d Thropolneoccus

e Thioderma

f Amoebomonas

g. Rhodothecc

h. Rhodonostoc

Thiophysa Order 2 Pseudomonadales

Family 1. Pseudomonadaceae

Genus a. Pseudomonas b. Rhodobacıllus

e. Chromatium d. Nitrosomonas

e. Vibrio

f. Rhadavibria

g. Myrococcus h. Spírillum

i. Rhodospirillum

i. Thiospira k. Thiospirillum

Family 2. Serratiaceae Genus a. Serratia b. Hillhousta Family 3. Nitrobacteriaceae Genus a. Nitrobacter

b. Rhodobacterium

c. Rhodocustis

d. Didymoheliz

e. Sideromonas

f. Siderocapsa

g. Chondromyces

h. Polyangium

i. Amoebobacter

j. Thiodictyon

Family 4. Azotobacteriaceae Genus a. Rhizobium

b. Azotobacter

Order 3. Leptotrichales

Family 1. Leptotrichaceae

Genus a. Leptothriz b. Sphaerotilus

c. Crenothrix

Family 2. Clonothrichaceae

Genus a. Clonothrix

Order 4. Rhahdomonadales Family 1. Rhabdomonadaceae

Genus a. Beggiatoa

b. Rhabdomonas

c. Thioploca

d. Thiothrix

Family 2. Spirochaetaceae Genus a. Spirachaeta

b. Treponema

c. Leptospira

d. Cristispira

e. Saprospira

Subclass B. Eubacteria Order 1 Aerobacteriales

Family 1. Aerobacteriaceae

Genus a. Aerobacter

b. Escherichia

c. Salmonella

d. Eberthella e. Shigella

Family 2. Pasteurellaceae

Genus a. Pasteurella

b. Brucella c. Haemophilus

d Neisseria

Order 2. Plocamobacteriales Family 1. Streptococcaceae Genus a. Streptococcus

Family 2. Ulvinaceae

Genus a. Proteus b. Kurthia

- Illaina
- d. Plocamobacterium
- e. Leptotríchia

Family 3. Bacteros daceae

- Genus a. Diolister
  - b. Aerobacteroides
  - c. Rasteroides
    - d. Fusobacterium
- Subclass C. Mucobacteria

Order 1. Bacillales

Family 1. Bacillaceae

Genus a. Bactrillum

- b. Aerobacillus
- c. Bacillus
- d. Anthracillus
- Family 2. Clostridiaceae

Genus a. Clustridium

b. Welchellus

Order 2. Mucobacteriales

Family 1. Mucobacteriaceae

Genus a Malleomuces

- b Actinobacillus
- c. Corvnebacterium
- d. Erysipelothrix
- e. Mucobacterium
- f. Distagna
- g. Tiasieria
- Family 2 Actinomycetaceae
  - Genus a. Actinomycoides

b Actinomuces

Janke (Cent. f. Bakt., II Abt., 80, 1930, 481) reprints the earlier outline prepared by Pribram (1929) and, after commenting on Lehmann and Neumann's (1927) outline, proposes an outline which is slightly modified from his own previous (1929) outline. Two new subgeneric terms are used. Angerobacillus and Eubacterium The sub-genus Acrobacillus is apparently not the same as Aerobacillus Donker (Inaug. Diss., Delft, 1926), nor as Acrobacillus Pribram (Jour. Bact., 18, 1929, 361).

Family I. Micrococcaceae

Genus 1. Micrococcus Divided into 2 sections.

Neisseria

- 3. Streptococcus
- Divided into 4 sections. 4. Sareina
  - Divided into 2 sections.

Family II. Bacillaceae

Genus 1. Bacillus

Sub-genus a. Anaerobacillus or better Clostridium Divided into 6 sections

Aerobacillus or better Eubacillus
 Divided into 10 sections.

Family III. Bacteriaceae

Genus 1. Bacterium

Sub-genus a Pseudomonas

Divided into 6 sections.

b. Eubacterium
Divided into

Divided into 11 sections.

c. Trichobacterium

Divided into 6 sections.

Genus 2. Fusiformis

Family IV. Corynobacteriaceae

Genus 1. Mycobacterium

2. Pfeifferella

3. Erysipelothrix

4. Corynobacterium

5. Actinomyces

Family V. Spirillaceae

Genus 1. Microspira or Vibrio

Sub-genus a. Microspira

b. Spirosoma

Genus 2. Spirillum Sub-genus a. Spirella

b. Dicrospirillum

Family VI. Spirochaetaccae

Genus 1. Spirochaeta 2. Cacospira

Cacospira
 Entomospira

4. Treponema

5. Cristispira

6. Saprospira

7. Leptospira

Family VII Desmobacteriaceae

As in 1929 outline.

Family VIII. Myzobacteriaceae
As in 1929 outline.

Kluyver and Van Niel (Cent. f. Bakt., II Abt., 94, 1936, 369) have developed an outline classification in which they indicate four lines of development from the simplest form of cell that is existent and conceivable, the sphere. They assign family rank to each of these four groups of bacteria, placing the lophotrichous (and related non-motile) rod-shaped bacteria (first (Pseudomonadaceae). This is followed by the family of spherical bacteria (Micrococcaceae) and the family of permanently non-motile, rod-shaped bacteria (Algobacteriaceae). The final family includes the peritrichous (and related non-motile) rod-shaped bacteria, the Bacteriaceae. These are grouped in the tribes of each family in accordance with their fundamental metabolism as photo-autotrophic, photo-heterotrophic, chemoautotrophic and chemo-heterotrophic. Their outline follows:

#### Family A. Pseudomanadarene

## 1. Tribe Spirillege

#### Genus 1, Thiospirillum

- 2 Phaeospirillum. 3. Rhodospirillum
- 4. Sulfospirillum 5. Spirillum

#### II Tribe Vahranene

#### Genus I. Chromatium

- 2. Rhodovibria

  - 3. Didymohelix 4. Vibrio
- 5. Desulfovibrio

## III Tribe Pseudomonadege

#### Genus 1. Thiathere

- 2. Phaeomonas
- 1. Rhodonzonas
- 4. Sulfomonas
- Sideromonas 5
- Natroso monas ß
- 7. Natrobacter
- 8. Acetobacter
- 9. Pseudomonas
- 10. Rhizobium
- 11. Azotobacier
- 12. Listerella
- 13. Acromonas
- 14 Zumomonas 15 Methanobactersum

## Family B. Micrococcaceae

## IV Tribe Micrococceae

#### Genus 1. Chlorobium

- 2 Thropolycoccus
- 3 Rhodococcus
- 4. Achromatium
- 5. Siderocapsa
- 6. Natrosococcus
- Neisteria
- 8. Microcorcus
- 9 Verillon ella
- 10 Peptococcus
- 11 Methamococcus

## V. Tribe Sarcinege

## Genus I. Thieredia

- 2. Thioraxcina
  - 3. Gallkya
  - 4. Sarcina
  - 5. Zymosarcina
  - 6. Hutgrisoreina
  - 7. Melhamosarcina

VI. Tribe Sporesarcineae

Genus 1. Sporosarcina

VII. Tribe Streptococceae

Genus 1. Peptostreptococcus

2. Streptococcus

3. Betacoccus

Family C. Mycobacteriaceae

VIII. Tribe Corynebactericae

Genus 1. Corynebacterium 2. Fusiformis

3. Propionibacterium

4. Streptobacterium

5. Betabacterium

IX. Tribe Mycobacteriege

Genus 1. Mycobacterium

2. Thermobacterium

Family D. Bacteriaceae X. Tribe Bactericae

Genus 1. Kurthia

2. Alcaligenes

3. Bacterium

4. Aerobacter

XI. Tribe Bacillean

Genus 1 Racillus 2. Aerobacillus

3. Zymobacillus

4. Clostridium

5. Peptoclostridium

Some old names are displaced by new descriptive terms: Phacospirillum Sulfospirillum, Desulforibrio, Phacomonas, Acromonas, Zymomonas, Methanobacterium, Methanococcus, Methanosarcina, Butyrisarcina, Peptococcus, Pentostreptococcus, Zumobacillus. Rhodomonas is not used in the same sense as Rhodomonas Orla-Jensen (Cent. f. Bakt., II Abt., 22, 1909, 331 and 334). the latter being a synonym of Chromatium Perty (Zur Kenntniss kleinster Lebensformen, 1852). Sulfomonas is indicated as new and as a synonym of Thiobacillus Beijerinck (Cent. f. Bakt., II Abt., 11, 1904, 598) although the same term is used by Orla-Jensen (loc. cit.). Three new terms are accepted: Chlorobium Nadson (Bull. Jard. Bot. St. Petersburg, 6, 1906, 184), Zymosarcina Smit (Die Garungssarcinen, Jena, 1930) and Peptoclostridium (Donker, Inaug. Diss., Delft, 1926).

Rahn (Cent. f. Bakt., II Abt., 96, 1937, 273) has reviewed the characters of the species of Eubacteriales included in the fourth edition of this MANUAL. He places 146 of the spore-forming species in a Sub-order A. Endosporales with a single family, and 536 of the species of non-spore-forming rods in a Sub-order B. Asporales in seven families. Unclassifiable species (total 224) are placed in a temporary eighth family Bacteriaceae. His outline follows: Order Eubacteriales

Suborder A. Endosporales

Pamily I. Endosporaceae

Genus 1. Bacillus

2. Aerobacillus

3. Clostridium

Suborder B. Asporales

Family I. Gramozidaceae

Genus 1 Micrococcus (including Staphylococcus, Gaffkya, Rhodococcus and most of the species of Sarcina)

2. Kurthia

Family II. Gramanoxida ceae

Tribe a Streptococceae

Genus 1. Streptococcus (including Diplococcus)

2. Leuconostoc

3 Peptostreptococcus

Tribe b Lactobacilleae

Genus 4 Lactobacillus (including part of Bacteroides)

5 Propionibacterium

Tribe c. Sarcineas

Genus 6. Zymosarcina

7. Butyrisarcina 8 Methanosarcina

Family III. Neissereaceae

Genus 1. Neisseria 2 Veillonella

Family IV. Protobacteriaceae

Tribe a. Protobactericae Genus 1 Carboxydomonas

108 1 Carontyanmone 2. Methanomonas

Tribe b. Natrobacterieae

Genus 1. Nitrosomonas

enus 1. Nitrosomona: 2. Nitrobacter

3. Nitrosococcus

Family V. Enterobacterraceas

illy V. Enterobacteriaceae
Genus 1. Enterobacter (including Escherichia, Sal-

monella, Aerobacter, Klebstella, Proteus, Erwnia, Ebethella, Shigella, and parts of Serratia, Pseudomonas, Flavobacterium and Aebromobacter)

Family VI. Pseudomonada ceae

Genus 1. Pseudomoras (includes Phytomoras and other lophotrichous types only)

2. Vibrio

3. Spirillum

4. Acetobacter

5. Azotobacter

6. Rhizobium

Family VII. Parvobacteriaceae

Genus 1. Brucella

2. Pasteurella

3. Hemophitus (including Dialister)

Family VIII. Bacteriaceae

Unclassifiable genera including Alcaligenes and Prolaminobacter; some species from each of the following genera, Achromobacter, Chromobacterium, Cellulomonas, Bacteroides, Flavobacterium, Phytomonas, Pseudomonas, Serraita; and three species from the Family Nitrobacteriaceae.

One of the generic terms used in this outline is new, i.e., Enterobacter. Two other generic terms, Fluorescens and Erythrobacterium, are proposed incidentally (p. 284). The first includes the peritrichous forms included in the Manual under Pseudomonas and the second includes those red, non-spore-forming rods that are not included in Serratia. In another footnote (p. 281) a substitute, Virgula, is suggested for Enterobacter. Emphasis is placed on sporulation, Gram stain, and oxygen demand as the most important characters aside from cell form and flagellation.

Prévot, as an outgrowth of his studies on anaerobes with Weinberg (Weinberg, Nativelle and Prévot, Les microbes anaérobies, 1937, 1186 pp., Paris), has written a series of papers in which he has developed a classification of anaerobic bacteria (Ann. Sci. Nat., 10 Sér., 15, 1933, 23-260; Ann. Inst. Past., 60, 1938, 285-307; 61, 1938, 72-91; 64, 1940, 117-125). The conclusions reached in these studies are summarized in his Manual de Classification et de Détermination des Bactéries Anaérobies, Monographie de l'Institut Pasteur, Paris, 1940, 223 pp. He regards the bacteria as comprising a kingdom, Schizomycetes, intermediate between the animal and plant kingdoms and notes the presence of strict anaerobes in at least three of the seven orders recognized in the 5th edition of the Manual. These orders he regards as classes. The genus Bacteroides Castellani and Chalmers (Manual of Trop. Med., 3rd ed., 1919, 959) type species, Bacteroides fragilis, is dropped (Ann. Inst. Past., 60, 1938, 288), and several new terms are proposed for the organisms included by Castellani and Chalmers and later investigators in the genus Among the new generic names is Ristella which is based on Ristella fragilis, the species used by Castellani and Chalmers as the type species for Bacteroides.

The complete outline classification developed by Prévot in his Monograph (loc. cit., p. 17) is given below:

Kingdom. Schizomycetes Nägeli Class I. Eubacteriales Sub-Class I. Non sporogenous Eubacteriales Order I. Micrococcales Family I. Neisstriaceae

Tribe I Neissericae Genus a Neisseria

Tribe 2 Veillonelleae Genus a Veillonella

Family 2 Micrococeaceas

Tribe I Streptococceae Genus a Diplococcus

Benus a Diplococcus
b Streptococcus

Tribe 2 Staphylococcus

Genus a. Gaffkia

b. Staphylococcus

Tribe 3 Micrococceae Genus a Sarcina

Genus a Sareina b Micrococcus

Order II. Bacteriales

Family 1 Ristellaceae Genus a Ristella

b Pasteurella

c. Dralister

d. Zuberella e. Cansularis

Pamily 2. Bacteriaceae

Genus a Cubacterium

b Catengbacterium

e. Banubacterium

d Cillobacterium Order III. Spirillales

Family 1 Vibrionaceae Genus a. Vibrio

Sub-class II Sporogenous Eubacteriales
Order I Clostrudiales

Family 1 Endosporaceae

Genus a Endosporus

b Paraplectrum

Family 2 Clostridiaceae Genus a Inflabilis

b. Welchia

c Clastridium

Order II Plectridiales

Family 1 Terminosporaceae Genus a Terminosporus

b. Caduceus Family 2 Pleetridiaceae

Genus a. Plectridium

b · Acuformis

Order III. Sporovibrionales
Family 1. Sporovibrionaceae
Genus a Sporovibrio

Class II. Actinomycetales

Family 1. Spherophoraceae

Genus a. Spherophorus

b. Spherocillus

c. Fusiformis d. Fusocillus

e. Leptotrichia

Family 2. Actinomycetaceae

Genus a. Actinobacterium

b. Bifidibacterium

c. Corynebacterium

Class III. Spirochetales Family 1. Spirochaelaceae

Genus a. Trevonema

b. Borrelia

In this outline, there are minor modifications in the names and in endings given to the orders and tribes as compared with those given in his preliminary papers. In the Order Micrococcales, Leuconostoc has been dropped as a genus of the tribe Streptococceae and Rhodococcus has been dropped as a genus of the Tribe Staphylococceae. Veillonella proposed by Prévot as a new genus in 1933 (loc. cit., p. 70) is included as a genus in the Family Neisscriaceae. The spelling of Gaffkya is changed to Gaffkia. In the first of Prévot's papers published in 1938 (loc. cit.), he proposes the following new genera in the Order Bacteriales: Ristella, Zuberella, Capsularis, Eubacterium, Catenabacterium, Ramibacterium and Cillobacterium. In the same paper he also proposes the following new genera in the Order Actinomycetales: Spherophorus, Spherocillus, Fusocillus, Pseudoleptothrix (withdrawn in 1940 in favor of Leptotrichia Trevisan). He also accepts one genus Actinobacterium (Haas, Cent. f. Bakt., I Abt., Orig., 40, 1906, 180) not previously mentioned in this discussion. With the single change noted (Pseudoleptothrix to Lepototrichia), the outlines of the genera in the orders Bacteriales and Actinomycetales remains in the 1940 outline as it was given in 1938.

In the outline given in Prévot's Monograph (loc. cit., p. 17) one change is made in the generic terms recognized in the Order Clostridiales from those recognized in his second paper published in 1938. The genus name Palmula proposed in 1938, having been found to be invalid because of prior use for a genus of Protozoa, is changed to Acuformis. Other generic names which appeared for the first time in the 1938 outline are Endosporus, Inflabilis, Terminosporus and Caduceus. Welchia proposed by Prévot in 1933 (loc. cit., p. 44) was previously proposed by Pribram (Jour. Bact., 18. 1929, 374) for the same group of anaerobic spore-forming rods. A third order, Sporombrionales, is proposed by Prévot in his Monograph (loc. cit... p. 15) to include the family Sporovibrionaceae (Ann. Inst. Past., 64, 1940,

119). This order and family include a single genus Sporovibrio Starkey (Arch. f. Microb., 9, 1938, 300) syn. Desulfovibrio Kluyver and Van Niel (Cent. f. Bakt., II Abt., 94, 1936, 389). Two genera (Treponema and Borrelia) of Spirochactales are listed by Prevot in his Monograph (loc. cit... p. 16) as including anaerobic species.

Stanier and Van Niel (Jour. Bact., 42, 1941, 437-466) have proposed a rearrangement of the classification outline as indicated below:

> Kingdom Monera Division I Muzophyta (Blue-green algae) Division II Schizomycetae (Bacteria) Class I Eubacteriae Order I Rhodobacteriales Eubacteriales Order II Actinomycetales Order III Muxobacteriae Class II Order I Murchacteriales Class III Snirochaetae Order I Spirochaetales Appendix to Division Schizomucctae Includes two families, Leptotrichaceae and Crenothri-Group I caceae

Achromatiaceae Group II

Group III Pasteuriaceae (Includes three genera, Pasteuria, Hyphomicrobium and Blastocaulis)

The genera Mycobacterium, Corynebacterium, Erysipelothrix, Leptotrichia. Nevskia, Gallionella, Caulobacter, Thiospira, Siderocapsa and Sideromonas are placed in Eubacteriales. Two genera not previously discussed in this review whose relationships to other bacteria have recently been clarified are Sporocytophaga Stanier (Jour. Bact., 40, 1940, 629) and Cutophaga Winogradsky (Ann Inst. Past., 43, 1929, 578).

This rearrangement has been carried out by including the organisms placed in the Order Caulobacteriales Henrici and Johnson (Jour. Bact., 30, 1935, 61-93) in the Order Eubacteriales (Buchanan, Jour. Bact., 2, 1917. 162). The genera of the Order Chlamydobacteriales Buchanan (loc cit.) are transferred to an appendix or are dropped (Clonothrix) as belonging to the blue-green algae. Three of the remaining five orders are raised to the rank of classes, one of which (Eubacteriae) includes three orders Rhodobacteriales (Pringsheim, Lotos, 71, 1923, 351), Eubacteriales (Buchanan. loc. cit.) and Actinomycetales (Buchanan, loc. cit.). Rhodobacteriales includes the sulfur purple, the non-sulfur purple and the green bacteria. the colorless sulfur bacteria (Beggiatoaceae) being transferred to the Myxonhuta with the change of the name of the Order from Thiobacteriales Buchanan (loc. cit.) to Rhodobacteriales Pringsheim (loc. cit.).

The entline classification below is proposed by the Editorial Roard of the MANTAL for use in the present (6th) edition of the MANTAL. It is based on those developed by Rergey et al. in earlier editions. These, in turn, were based on the outline classifications developed by Buchanan (Jour. Bact., 7, 1916, 591; 6, 1917, 185 fl.; 8, 1918, 27 fl.) and Winslow et al. (Jour. Ract., 8, 1920, 191).

Phylum Schierrhita Class I. Schunglipress Class II. Schulmurgles Order L. Exhasterialis Sub Order I Er beeteriinese jineliides Cerand ieterisesse) Sub-Order 11. Carlobatemente Sub-Order III. Rhalobicierimore Order II. Actinomicetales uncludes Metalasterium, Actinomices, and related ceneral Order III Chlamedobacteriales Leptoterchaerae Family I. Family II. Crenothrichaceae Family III. Beggintogeege

Appendix Achromatiocea.
Order IV. Myzobacteriales
Order V. Surechaetales

Supplement: Groups whose relationships are uncertain.

Group I Order Recletistates, Group II. Order Virales, Group III, Family Borrelemycetacene,

In this, the arrangement of Schizomycetes as a class coordinate with Schizophyceae, both belonging to a phylum Schizophyla of the plant king-dom, is maintained as before. The number of orders is reduced from seven as given in the fifth edition of the Maxuat to five, through recognition of the fact that the rigid, uniceflular, sometimes branching but never truly mycelial nor filamentous organisms belonging to three of the previously recognized orders are presumably more closely related to each other than they are to the organisms in the four remaining orders. The family Coryme-bacteriaceae has been transferred from the order Actinomycetales to Eubacteriales.

The colorless, filamentous, sulfur bacteria (Beggiatanccae) have been placed in the order Chlamydobacterials with the other filamentous bacteria that are clearly related to the blue-green algae. While this marks the greatest deviation from the outline previously used, and separates these colorless sulfur bacteria from the purple sulfur bacteria placed in Rhodobacteriineae, it is in accordance with the arrangement accepted by Lehmann and Neumann (Bakt. Diag., 4 Aufl., 2, 1907, 598), Pringsheim (Loter, 71, 1923, 307) and others. Rhodobacteriineae is also limited to the purple and green bacteria as suggested by Pringsheim (loc. cit.) and accepted by Kluyver and Van Niel (loc. cit.), by Stanier and Van Niel (loc. cit.) and others.

The Rickettsiales and Borrelomycetaceae are placed in a supplement as their relationships are still obscure. Several authors would place them near some of the organisms now placed in Pasteurella and Haemophilus. The viruses (Virales) whose nature and relationships are still more obscure are also placed in a supplemental group.

Although this outline maintains the simplicity that distinguished its predecessors, and provides places for all types of microorganisms thus far described that may properly be grouped under the fission fungi, it should not be regarded in any sense as final. An attempt has been made to express natural relationships, but these are so frequently obscure or unknown that in many places utilitarian considerations have prevailed. In some places, groups of known doubtful significance have been allowed to stand as they are out of a desire not to make unnecessary changes. It has appeared desirable to be conservative in making changes in the outline as used previously.

Addenda: After the above was in page proof, it was discovered that reference to the outline classification of Gieszczykiewicz (Bull. Adad. Polonaise d. Sci. et d. Lettres, Cl Sci. Math. et Nat., Sér. B., 1939, 27 pp.) had inadvertently been omitted. This outline has some features like the outline that Lehmann and Neumann used in 1927 (see p. 17) and some like the outline used in the 4th ed. of the Manual.

The genus Bacterium is retained as in the Lehmann and Neumann outline for Gram-negative, non-spore-forming, peritrichous or polar flagellate rods. Twelve sub-genera are recognized and these bear subgeneric scientific names that are much the same as those used for genera in the 4th ed, of the Manual. A new subgeneric name Enterobacterium (see Enterobacter Rahn) is proposed to cover the genera Escherichia, Aerobacter, Klebsiella, Salmonella, Eberthella and Shigella. Loefflerella previously used by Gay et al. (Agents of Discase and Heat Resistance, Indianapolis, 1935, 782) is here also used as a subgeneric name for the glanders bacillus; and Chromobacterium is used for the organisms more properly placed in Serratia Bixio.

Corynebacterium is transferred from the order Actinomycetales to Eubacteriales and the family Corynebacteriacca is made to include Lactobacillus, Erysipetolthrix and Fusobacterium. Among the Spirochactales, the genus aame Spirochacta is displaced by a new generic term, Ehrenbergia, and is itself used to displace Borrelia.

A seventh order Richettsiales is proposed to include two families: Richettsiaceae with one genus Richettsia da Rocha Lina (Berl, klin, Wehnschr.,
1916, 567); and Bartonellaceae with the genera, Bartonella Strong, Tyrzer,
Brues, Sellards and Gastiaburú (Jour. Amer. Med. Assoc., 61, 1913,
1713), and Grahamella Brumpt (Bull Soc. Path Exot. 4, 1911, 514).

During 1945, Soriano (Ciencia e Investigación, 1, 1945, 92-91 and 146-147; Rev. Argentina de Agronomia, 12, 1945, 120) proposed an arrangement of the Class Schizomyceles in which he recognizes a new Order, Flexibacteriales, to include the 'families Cytophagaceae and Beggiatoaceae and an entirely new Family Flexibacteriaceae containing a single genus Flexibacter. The latter includes five newly recognized species of flexuous bacteria as follows: Flexibacter flexilies, type species, F. elegans, F. giganteus, F. albuminosus and F. gurcus.

The outline given below shows how this new order and new family are fitted by Soriano into the classification used in the fifth edition of the MANUAL.

#### Class Schizomycetes

Subclass Eubacteria. Rigid cells. Subclass Flexibacteria. Flexuous cells.

Order I, Eubacteriales

Order VI. Flexibacteriales

Order II. Caulobacteriales Order III. Rhodobacteriales Order IV. Actinomycetales Order V. Chlamudobacteriales Order VI. Flexibacteriales
Family I. Cytophagaceae
Family II. Beggnatoaceae
Family III. Flexibacteriaceae
Order VII. Myzobacteriales
Order VIII Spirochactales

Prévot (Ann Inst. Past. 72, 1946, 1) has developed his classification of Class Actinomycetales, subdividing it into orders and including several genera not recognized in his 1940 outline. This classification is as follows:

#### Class Actinomucetales

Order I Actinobacteriales New order Not acid-fast

Family I Spherophoraeae
Genus I Spherophoras
Genus I Harerhilia
Genus II Harerhilia
Genus IV Fusiornis
Genus IV Fusiornis
Genus V Fusocillus
Genus V Expocitius
Genus V Leptotrchia
Genus VI Leptotrchia

Order II Mycobacteriales New order Acid-fast

Genus I Mycobacterium

This classification differs from that used in this edition of the Manual in that it places several genera of Gram-negative organisms in Actinomy-etales These are Spherophorus, Haverhillia, Spherocillus, Fusiformis and Fusocillus, all of which are included here under Parobacteriacaca. Leptotrichia which Prevot regards as Gram-negative is generally accepted as being a Gram-positive group. It is discussed in this edition of the Manual in connection with the genus Lactobacillus.

#### HOW BACTERIA ARE NAMED AND IDENTIFIED\*

Some principles of taxonomy and nomenclature. "Taxonomy is that branch of biology that deals with the orderly arrangement of plants and animals" (Johnson, Taxonomy of the Flowering Plants, New York, 1931, p. 3).

The necessity for applying names to species or kinds of bacteria is selfevident. It is highly desirable that the name applied to an organism by one person should be understood by others. It is further desirable that as far as practicable all individuals use the same name for the same kind of organism. It is helpful, therefore, if there can be an agreement regarding the method of naming organisms, and as to the correct name for each organism. The term nomenclature is applied to the naming of plants and animals, and under this term may be included all discussions as to methods of naming and correctness of particular names.

It is not enough that bacteria be named. Some method of classification of the bacteria is essential if the names are to be rendered accessible and available, and identification of unknown forms be made possible. Taxonomy is that branch of biology which treats of classification in accordance with a convention or law. It is apparent that taxonomy must be dependent in part for its satisfactory development upon nomenclature. Even though there may not be agreement among bacteriologists as to the exact classification that is to be used, nevertheless it is highly desirable that there be agreement as to some of the fundamental characteristics of satisfactory biological classifications in general

What kinds of names are used. Two kinds of names are commonly given to the different kinds of plants and animals, the common, provincial. vernacular or casual names on the one hand and the international or scientific names on the other. These should be carefully differentiated, and their respective advantages and disadvantages noted.

It is inevitable, and on the whole probably desirable, that for each kind of familiar animal or plant in each language there will be coined a name. Usually the name for the same organism will be different in each language. For example, we have in English Oak, in German Liche, in Latin Quercus. etc. For many uncommon kinds, however, there may be no such vernacular names developed. There have been, of course, many casual or vernacular names given to kinds of bacteria. In English we speak of the tuberele bacillus, the typhoid germ, the gonococcus, the Welch bacillus, the golden

<sup>\*</sup> Contributed by Prof R. E. Buchanan, Iowa State College, Ames, Iowa, January. 1931; revised, March, 1913.

pus coccus, and many others. Similarly, we find in German Typhus-bazillen and in French bacille typhique, enterococcus, etc. The use of these common names offers certain advantages. It does away frequently with the necessity of repeating longer and more formal scientific names. Not infrequently scientific names may be adopted into a language, and converted into vernacular names. For example, the English name aster and the scientific generic name Aster are applied to the same group. This is frequently a convenience, but there are also some difficulties, which will be emphasized below.

In contrast to common, vernacular or casual names, the scientific name for each kind of organism (each plant or animal) is supposed to be the same in all countries and in all languages. When such a scientific name is used, no question should arise in any language as to what organism is intended. The names thus applied are supposed to conform to certain general rules that have been formulated by international agreement. Obviously the use of such names is advantageous whenever one is desirous of accuracy, and of being definitely understood in all languages. It is further evident that in all questions relating to taxonomy and classification it is highly desirable that the scientific names be used.

International rules for nomenclature. In order that there be an international set of scientific names, it is essential that there be an international agreement as to the rules which should govern their creation. Both of the great groups of biologists, the botanists and the zoologists, have met in numerous international congresses in which delegates were accredited by the great botanical and zoological societies, museums, and educational institutions of the world. Codes of nomenclature designed to tell how names shall be manufactured and used, and how to tell which of two or more names that have been used is correct, have been developed by each of these groups. These codes or lists of rules and recommendations are quite similar in essentials for botany and zoology, although they differ in some details.

The question arises: Are either or both of these codes satisfactory or adaptable to the use of bacteriologists. Three views have been expressed by various writers. Some few have suggested that the naming of bacteria cannot well conform to the approved international rules as their classification involves considerations not familiar to botanists and zoologists generally. The second group, also a very small one, has insisted that unicellular forms of life are neither plants or animals, but protista, and that taxonomic rules, etc., should be distinct for this group and coördinate with the corresponding rules for plants and for animals.

The third view, more commonly expressed, is that the bacteria are sufficiently closely related to the plants and animals, so that (in so far as

they apply) the international agreements of the botanists (or zoologists) should be used as a basis for naming them.

International opinion on this topic was finally crystallized by resolutions adonted by the First International Congress of the International Society for Microbiology held in Paris in 1930 and by the Fifth International Botanical Congress held in Cambridge, England in the same year.

The resolutions unanimously adopted by the plenary session of the International Society for Microbiology were in part as follows:

"It is clearly recognized that the living forms with which the microbiologists concern themselves are in part plants, in part animals, and in part primitive. It is further recognized that in so far as they may be applicable and appropriate the nomenclatural codes agreed upon by International Congresses of Botany and Zoology should be followed in the naming of micro-organisms. Bearing in mind, however, the peculiarly independent course of development that bacteriology has taken in the past fifty years. and the elaboration of special descriptive criteria which bacteriologists have of necessity developed, it is the opinion of the International Society for Microbiology that the bacteria constitute a group for which special arrangements are necessary. Therefore the International Society for Microbiology has decided to consider the subject of bacterial nomenclature as a part of its permanent program."

The International Society of Microbiologists established a permanent Nomenclature Committee to pass upon suggestions and to make recommendations. This committee is composed of members from all participat-Two secretaries were named, one (Dr. St. John-Brooks of the Lister Institute, London, England) to represent primarily medical and veterinary bacteriology, and one (Dr R. S. Breed, New York State Agricultural Experiment Station, Geneva, New York, U. S. A) to represent other phases of bacteriology.

The cooperation of the International Botanical Congress was solicited in the naming of this committee. The resolutions were approved by the Section on Bacteriology of the Botanical Congress and the Congress itself incorporated into the Botanical Code certain special provisions relating to the bacteria. It also specifically recognized the International Committee as the body to prepare recommendations relating to bacterial nomenclature.

It is apparent, therefore, that there has been international agreement (in so far as this can be achieved) that bacteriologists should follow the botanical or zoological codes in the naming of bacteria to the extent they are applicable, and that exceptions or new problems should be presented to the International Committee.

These rules are so important in determining the validity of bacterial names that the rules of the Botanical Code are included in somewhat abridged form in the section that follows this introduction. Any student who has occasion to name a new species or a new genus or determine the validity of a name should familiarize himself with these rules and recommendations.

An effort has been made in the present volume to use nomenclature in conformity with these rules.

Some general principles of nomenclature. Every student of bacteriology should be familiar with certain rules of nomenclature if he is to use names intelligently. If he wishes to correct names improperly used or if he desires to name new species, there are additional rules which he must observe.

- 1. Each distinct kind of bacterium is called a species.
- 2. To each distinct species a name is given consisting usually of two Latin words, as Bacillus subtilus.
- 3. The first word is the name of the genus or group to which the organism belongs. It is always written with a capital letter. It is a Latin or Greek word, or a new word compounded from Latin or Greek roots, or it may be derived from some other language; but this is important, whatever its origin when used as a generic name it must be regarded and treated as a Latin noun. If it is a word not found in classic Latin, it is regarded as modern Latin.' Some generic names in bacteriology which are Latin or formed from Latin roots are Bacillus (masculine) a small rod; Cristispira (feminine) a crested spiral; Lactobacillus (masculine) a milk small rod; Sarcina (feminine) a packet or bundle. Many others are words from the Greek or compounded from Greek roots, with the words transliterated into Latin letters and endings in conformity with Latin usage; words of Greek origin are Micrococcus (masculine) a small grain (sphere); Bacterium (neuter) a small rod, Clostridium (neuter) a small spindle; Corunebacterium (neuter) clubbed small rod; Actinomyces (masculine) ray fungus. Other generic names have been given in honor of persons or places as Beggiatog (feminine). Borrelia (feminine), Eberthella (feminine), Pasteurella (feminine), Erwinia (feminine), Zopfius (masculine).
- 4. The second word in the scientific name is a specific epithet. It is not capitalized except that certain authors capitalize species names derived from proper nouns.

It may be:

(a) An adjective modifying the noun, and indicating by its ending agreement with the generic name in gender, as Bacterium album (white Bacterium), Bacillus albus (white Bacillus), Sarcina alba (white Sarcina), Eberthella dispar (the different Eberthella), Bacterium variabile (the variable Bacterium), Brucella melitensis (the maltese Brucella), Bacillus teres (the rounded Bacillus), Bacillus gravolens (sweet-smelling Bacillus).

Masculine albus niger tener acer variabilis	Typical adjectives Feminine alba nigra tenera acris variabilis	Neuter album nigrum tenerum acre
variabilis díspar		acre variabile dispor coccoides
coccordes aerogenes	coccoides aerogenes	

- (b) An adjective in the form of the present participle of a verb, as Clostridium dissolvens (the dissolving Clostridium, in the sense of the Clostridium which is able to dissolve), Bacillus adharens (the adhering Bacillus), Acetobacter ascendens (the climbing Acetobacter), Bacillus esterificans (the ester-producing Bacillus). The endings for present participles used as adjectives are the same for all genders. The past participle is used occasionally, as in Pseudomonas aptata (the adapted Pseudomonas), Spirillum attenuatum (the attenuated Spirillum).
- (c) A noun in the genitive (possessive) modifying the generic name. There is no necessary agreement in gender or number. Examples, Clostridium welchii (Welch's Clostridium), Salmonella pullorum (the Salmonella of chicks), Streptococcus lactis (the Streptococcus of milk), Brucella abortus (the Brucella of abortion), Clostridium tetani (the Clostridium of tetanus), Diplococcus pneumoniae (the Diplococcus of pneumonia), Salmonella anatum (the Salmonella of ducks)
- (d) A noun in apposition, that is, an explanatory noun. This does not agree necessarily with the generic name in gender. This method of naming is relatively not common in bacteriology. Examples are Actinomyces scalics (the sourf or seah Actnomyces), Bacillus lacticola (the milk-dweller bacillus), Bacillus radicicola (the root-dweller bacillus).
- 5. The author of the name is often indicated following the name of the species, as Bacillus sublitis Colm. Sometimes a name is indicated also in parenthesis, as Micrococcus luteus (Schroeter) Colm. This means that Schroeter first named the species, giving it the name luteus, but placed it in another genus (Bacteridusm). Colm placed it in a new genus. It should be noted that the name of a person, following the name of an organism is frequently not the person who first discovered or described it, but the person who first gave it the name used. For example, Clostridium welchii (Migula) Holland was first described by Dr. Wm. H. Welch, but not named by him. It was named by Migula in honor of Dr. Welch not later it was placed in the genus Clostridium by Holland.
- Sometimes species of bacteria are subdivided into varieties. These are likewise given Latin designations, and the entire name written as:

Streptococcus lactis var. maltigenes (the Streptococcus of milk producing malt flavor).

Some principles of taxonomy. It is important further that the student of bacteriology recognize the meaning of certain terms used regularly in classifications.

(1) Species (plural species). A species of plant (or animal) is assumed above to be one kind of plant. But how much difference must exist between two cultures of bacteria before one is justified in regarding the organisms in them as being of distinct kinds or species? No rule can be laid down. It depends largely upon convenience and a more or less arbitrary decision. As stated by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 8): "The unit of classification is a coherent group of like individuals, called a species. The term is difficult to define with precision because a species is not a definite entity, but a taxonomic concept." Hucker and Pederson (New York Agric, Exper. Sta. Tech. Bull. 167, 1930, p. 39) state: "The difficulty met with among these lower forms in dividing them into well-defined groups has led many to question whether these small groups or 'species' are natural groups and whether such groups can be considered to be similar to 'species' among higher forms. However this may be, it is necessary to arrange bacteria as well as possible into groups or so-called 'species' for convenience in classification," and again (Hucker, New York Agric, Exper. Sta. Tech. Bull. 100, 1921, 29), "characters applicable to the differentiation of species must evidence a certain amount of constancy when studied over a large series of tests. Furthermore, characters adapted to the differentiation of larger natural groups or genera should, in addition to constancy, show some correlation with other constant characteristics. The presence of this relationship or correlation between characters for the division of genera indicates that the groupings are being made along natural rather than artificial lines."

Type culture. It is quite evident that when a new species of bacterium is described, it must include the particular culture from which the species description was made. This original culture is termed the type culture. We may develop a definition as follows:—A species of bacterium is the type culture or specimen together with all other cultures or specimens regarded by an investigator as sufficiently like the type (or sufficiently closely related to it) to be grouped with it. It is self-evident that different investigators may not draw the same boundaries for a given species. This leads to some practical difficulties, but no better definition has been evolved.

There are certain special cases which require brief discussion.

(a) How should one designate the different stages in an organism that exhibits a growth cycle? There seems to be increasing evidence that certain bacteria show cycles in morphology which parallel to some degree those well

known among the fungi. Such, for example, may well be the rough (R) and smooth (S) types described for many bacteria, possibly the filterable stages noted by many authors, the so-called G types, etc. It is evident that an adequate description of any species of bacterium should include a description of each of these stages in the cyclical development wherever such is proved to exist. In all other cases in botany and in zoology which involve growth stages or cycles one stage has been chosen and designated as the mature or adult or perfect stage. In ferns, for example, names and classifications are based largely upon the sporophytic generation, in insects upon the adult or imago, in the rusts upon the stage in which the teleutospores are produced. There has been no international agreement as to what stage should be thus designated for the bacteria. Beyond doubt, it would be the stage which is most easily cultured and studied in the laboratory, the stage with which we are best acquainted in the laboratory. It might easily happen in bacteria (as it has with fungi) that two different stages of the life cycle of single species have been described and named as separate species. When the mistake has been discovered, the name given to the mature or perfect stage is the one that is accepted. In general the descriptions given in the present volume are those which may be regarded as belonging to the perfect stage. Unfortunately it is not yet possible accurately to group the stages in many of the bacteria that have definite growth cycles.

It is desirable frequently to designate the stage with which one is working. This may be done by some conventional symbol, as S (smooth type), G

(filterable stage), etc.

(b) How should one designate variants which differ in some minor respects from the type, but which do not constitute growth stages? For example, the species Bacillus subtilis normally produces endospores. Suppose that an asporogenous race is derived from such, agreeing with the parent culture in all respects, but showing no tendency to revert to spore production. What such an organism should be called is a matter of judgment. It might frequently be designated as an asporogenous strain, or more technically if one desires as a variety. It might be termed, for example, Bacillus subtilis var. asporus. In other cases such expressions as Diplococcus pneumoniae Type I, or the Rawlings strain of the typhoid bacillus may be used.

Unfortunately there is no general agreement upon the exact significance which the word "strain" should have in bacteriology. It is recommended that it refer merely to source, e g. the Rawlings strain of Eberthella lyphosa. and that it be never used to connote a biological character. This would not prevent such expressions as "a non-motile strain of Salmonella sucpestifer", but it would make erroneous a statement to the effect that the A

strain of influenza virus differs from the B strain in certain ways. In other words, "strain" is not a synonym of "type" or "variety". We may have as many yellow strains of the typhoid bacillus as we have of cultures of it, from different sources or specimens.

(2) Genus (plural genera). A genus is a group of related species. In some cases a genus may include only a single species (is said to be monotypic) in most cases several to many species are included in a genus. The question asked above may be paraphrased. How close must be the resemblances (how close the relationships) among the species of a group to entitle them to inclusion in the same genus? In other words, how is it possible to delimit accurately the boundaries of a genus? This is a matter on which there is no agreement, and probably can be none. Much of the confusion in modern bacteriological terminology is to be attributed to this fact, Nevertheless, in course of time experience tends to delimit many genera with reasonable accuracy. As stated by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 9): "Convenience may play a rôle in determining generic lines. Extremely large groups may be broken up on the basis of differences of smaller degree not common to a group of closely allied species, than if the group consisted of a few species. In general, the botanist, in delimiting genera, keeps in mind two important requirements, that of showing natural affinities and that of aiding correct identification." However, a genus may be defined helpfully in another way. One of the species described as belonging to a genus is designated as the type species. A genus may be defined then, as including this type species together with such other species as the investigator (or taxonomist) regards as sufficiently closely related. It is apparent that some authors may draw the lines narrowly, others broadly. Some authors, for example, recognize only two genera of rod-shaped bacteria, one for those without endospores (Bacterium), and one for those producing endospores (Bacillus). These genera thus defined are very large, each containing hundreds, perhaps thousands. of species. Other students break up these large genera into many smaller ones. There is not much point to the question as to which is right and which is wrong. A better question is, which is the more convenient, better represents relationships, better facilitates diagnosis and proves most useful. As organisms become better known, it may be possible through the agency of the International Committee on Nomenclature to reach agreements where lack of agreement leads to serious confusion or misunderstanding.

(3) Family. A family in taxonomy is a group of related genera. In general the name of the family is made from the name or former name of one of their genera by affixing the suffix -accae to the root. The word is regarded as plural. Among bacterial families commonly recognized are Bacillaceae, Bacteriaccae, Microoccaccae, Spirochaelaceae, Actinomycetaccae,

- (4) Order. An order is a group of related families. It is named usually (not always) by substituting the suffix -ales for -accee in the name of the type family. Among ordinal names that have been used in bacteriology are Actinomycetales. Springhaetales. Euhacteriales.
- (5) Class. A class is a group of related orders. In this treatise it is considered that the bacteria constitute a class of the plant kingdom, and this is named Schizomycetes.
- (6) Other categories. Other categories or ranks of names are used for higher groups. Sometimes families are divided into sub-families, these into tribes, these into subtribes, and these finally into genera.
- How to identify an organism by name. One of the main purposes of a manual of determinative bacteriology is to facilitate the finding of the correct scientific name of a bacterium. Such is the purpose of this volume. It is well, however, to note some of the reasons why this result, the identification of an unknown culture, may not eventuate. Among these reasons the following may be listed:
- (1) The unknown organism awaiting identification by the investigator may easily be one which has never been named, or perhaps adequately described. For the most part there has been little effort on the part of bacteriologists to describe or name bacteria except as they have been found to have some economic significance or possess some striking or unusual characteristics. It is quite probable that there are many times as many species of bacteria undescribed and named as have been described. Such undescribed species are all about us. It is not surprising, therefore, if one frequently encounters undescribed species. When such unnamed species are encountered, particularly if they are of economic importance or are related to such forms, it is highly desirable that they should be described, named and the results published and made accessible.
- (2) The unknown organism may have been described and named in some publication, but the description and name have been over-looked in the preparation of the Manual. Perhaps the description has been so inadequate or incomplete that it has not been possible to place it in the classification. It should be noted that the number of species that have been described is so great that no one individual can know them all. Progress in classification comes about largely as the result of the work of specialists in particular groups. For example, Ford made a study of all of the aerobic spore-bearing bacteria which he had secured from various sources. He studied also the descriptions of such bacteria in the literature, and then monographed the group. Similar studies on other groups have resulted in more or less complete monographs. Such, for example, are the monographs on the inte-tinal group by Welden and Levine, of the acetic bacteria by Hoyer, and Visser 't Hooft, of the cocci by Hucker, of the

pathogenic spore-bearing anacrobes by the English Commission, by Weinberg, and by others, of the red, rod-shaped bacteria by Helferan and by Breed, of the actinomycetes by Waksman and by Lieske, of the root nodule bacteria of legumes by Fred and his co-workers, etc. Unfortunately most groups of bacteria have not thus been monographed. It is evidently the function of a manual such as this to draw largely upon the work of the monographers, and to supplement their achievements as far as possible by less satisfactory consideration of the unmonographed groups.

It is clear that because an organism cannot be identified from this text is not proof that it has not been described and named. The species most closely related may be determined, then the literature searched carefully for species described still more closely related or perhaps one identical.

(3) It is possible, of course, that an error has been made in the selection of the correct name. It is desirable that users of these keys and descriptions should be familiar with the rules governing the correct choice of names, and make suitable corrections where needed.

Steps in determining the name of an organism. The steps in the identification of an unknown organism are usually the following:

- (1) Preparation of an adequate description of the organism.
- (2) Knowledge of construction and use of keys.
- (3) Determination of order, family and genus by use of key.

Preparation of description of organism. Before attempting to determine the name of an "unknown" organism an adequate description is essential. Just what characteristics must be emphasized depends upon the group in which the organism falls. It is desirable that the knowledge of the characters of the unknown be as complete as possible.

Use and construction of keys. An exceptionally clear and satisfactory discussion of the making and use of keys and synopses is given by Hitchcock (Descriptive Systematic Botany, New York, 1925, p. 101). Anyone planning to monograph a group is advised to read this. He states: "A key is an orderly arrangement of a series of contrasting or directly comparable statements, by which groups of the same category may be distinguished and indicated or identified," and "A key is primarily a mechanical device by which one may arrive at the name of the ultimate member of the group." In general the keys used in this Manual are dichotomous, that is, the successive divisions are in twos, differentiation being into two contrasted groups.

Determination of order, family and genus by use of keys. The method of doing this is discussed in the introduction beginning on page 1.

#### RULES OF NOMENCLATURE\*

In Paris in 1930, the First International Microbiological Congress voted to follow the rules of nomenclature agreed upon by International Congresses of Botany and Zoology "in so far as they may be applicable and appropriate." The adoption of the date of the publication of Species Plantarum by Linnaeus in 1753 as the point of departure for bacteriological nomenclature was recommended. This recommendation was approved by the plenary session of the Microbiological Congress (Proc. 1" Cong. Internat. Microbiol., Paris, 1930, 2, 1932, 519) and by the plenary session of the Botanical Congress (Rept. Proc. 5th Internat Bot. Cong., 1930, Cambridge, 1931, p. 16 and 23).

This Congress also provided for the organization of an International Committee on Bacteriological Nomenclature with two permanent secretaries:

- To represent primarily medical and veterinary bacteriology,—Dr. R. St. John-Brooks. Lister Institute, London, England
- To represent primarily other phases of bacteriology,—Dr. R. S. Breed, Experiment Station, Geneva, New York, U. S. A.

During the years that have elapsed since its appointment, this Committee has organized and has taken various actions in the interest of a more stable nomenclature and classification. Some of these have been completed and accepted by the Second International Congress of Microbiology held in London, 1936. These completed actions are quoted below, and are incorporated into the classification used in the descriptive portion of the Manual.

The International Rules of Botanical Nomenclature were originally adopted by the International Botanical Congresses of Vienna (1903) and Brussels (1910). They were modified by the Cambridge Congress (1930) so as to accept the type method, and validate species descriptions of bacteria unaccompanied by a Latin diagnosis. Some further but less important modifications were made at the Amsterdam Congress (1935) (See Sprague, Science, 83, 1936, 416).

The following are the most important of the rules that are of interest to bacteriologists taken from the latest available edition of the Botanical Code (Gustav Fischer, Jena, 1935). Sections that were newly adopted or amended by the Amsterdam Botanical Congress (1935) are indicated in the text

<sup>\*</sup> Contributed by Prof. R. S. Breed, New York State Experiment Station, Geneva, New York, September, 1938; revised, October, 1943.

#### INTERNATIONAL RULES OF BOTANICAL NOMENCLATURE, 1930–1935

#### Chapter I. General Considerations and Guiding Principles (Art. 1-9)

Art. 1. Botany cannot make satisfactory progress without a precise system of nomenclature, which is used by the great majority of botanists in all countries.

Art. 2. The precepts on which this precise system of botanical nomenclature is based are divided into principles, rules, and recommendations. The principles (Art. 1-9, 10-14 15-19) form the basis of the rules and recommendations. The object of the rules (Art. 19-74) is to put the nomenclature of the past into order and to provide for that of the future. They are always retroactive; names or forms of nomenclature contrary to a rule (illegitimate names or forms) cannot be maintained. The recommendations deal with subsidiary points, their object being to bring about greater uniformity and elearness in future nomenclature: names or forms contrary to a recommendation cannot on that account be rejected, but they are not examples to be followed.

- Art, 3 The rules of nomenclature should be simple and founded on considerations sufficiently clear and forcible for everyone to comprehend and be disposed to accept.
- Art. 4. The essential points in nomenclature are: (1) to aim at fixity of names; (2) to avoid or to reject the use of forms and names which may cause error or ambiguity or throw scence into confusion.

Next in importance is the avoidance of all useless creation of names.

Other considerations, such as absolute grammatical correctness, regularity or cuphony of names, more or less prevailing custom, regard for persons, etc., notwithstanding their undeniable importance, are relatively accessory.

- Art. 5. In the absence of a relevant rule, or where the consequences of rules are doubtful, established custom must be followed.
- Art. 7. Scientific names of all groups are usually taken from Latin or Greek. When taken from any language other than Latin, or formed in an arbitrary manner, they are treated as if they were Latin. Latin terminations should be used so far as possible for new names.
- Art. 8. Nomenclature deals with: (1) the terms which denote the rank of taxonomic groups (Art. 10-14), (2) the names which are applied to the individual groups (Art. 15-72).
- Art. 9. The rules and recommendations of botanical nomenclature apply to all groups of the plant kingdom, recent and fossil, with certain distinctly specified excentions.

#### Chapter II. Categories of Tazonomic Groups, and the Terms Denoting Them (Art. 10-14, Rec. I, II)

Art. 10. Every individual plant belongs to a species (species), every species to a genus (genus), every genus to a family (familia), every family to an order (orda) every order to a classic), every class to a division (diviso).

## Chapter III. Names of Tazonomic Groups (Art. 15-72, Rec. III-L)

- Section 1. General Principles: Priority (Art. 15-17, Rec. III)
- Art. 15. The purpose of giving a name to a taxonomic group is not to indicate the characters or the history of the group, but to supply a means of referring to it.

  Art. 16. Each group with a given circumscription, position, and rank can bear

only one valid name, the earliest that is in accordance with the Rules of Nomenclature.

## Section 2. The Type Method (Art. 18, Rec. IV-VII)

Art 18. The application of names of taxonomic groups is determined by means of omenclatural types. A nomenclatural type is that constituent element of a group o which the name of the group is permanently attached, whether as an accepted name or as a synonym. The name of a group must be changed if the type of that name is accluded (see Art. 66).

## Section 3. Lamitation of the Principle of Priority: Publication, Starting-points, Conservation of Names (Art. 19-22)

- Art. 19. A name of a taxonomic group has no status under the Rules, and has no claim to recognition by botanists, unless it is validly published (see Art. 37).
- Art. 20. Legitimate botanical nomenclature begins for the different groups of plants at the following dates:
  - (h) Myzomycetes, 1753 (Linnaeus, Species Plantarum, ed. 1).\*

Art. 21. However, to avoid disadvantageous changes in the nomenclature of genera by the strict application of the Rules of Nomenclature, and especially of the principle of priority in starting from the dates given in Art. 20, the Rules provide a list of names which must be retained as exceptions. These names are by preference those which have come into general use in the fifty years following their publication, or which have been used in monographs and important floristic works up to the year 1800.

# Section 4. Nomenclature of the Tazonomic Groups According to Their Categories (Art 23-35, Rec. VII-XX)

- 1. Names of Groups above the Rank of Family.
- Rec. IX. Orders are designated preferably by the name of one of their principal families with the ending -ales.
  - 2 Names of Families and Subfamilies, Tribes, and Sub-tribes.
- Art. 23. Names of families are taken from the name or former name of one of their genera and end in -aceae
  Art. 24. Names of subfamilies (subfamiliae) are taken from the name of one of the
- genera in the group, with the ending -oideae, similarly for tribes (tribus), with the ending -rae, and for subtribes (subtribus) with the ending -rae.
  - 3. Names of Genera and Subdivisions of Genera.
- Art. 25. Names of genera are substantives (or adjectives used as substantives), in the singular number and written with an initial capital, which may be compared with our family names. These names may be taken from any source whatever, and may even be composed in an absolutely arbitrary manner
- Recommendation X. Botanists who are forming generic names show judgment and taste by attending to the following recommendations.
  - (a) Not to make names long or difficult to pronounce.
  - (b) Not to dedicate genera to persons quite unconnected with botany or at least with natural science, nor to persons quite unknown.
  - (c) Not to take names from barbarous languages, unless those names are frequently cited in books of travel, and have an agreeable form that is readily adaptable to the Latin tongue and to the tongues of civilized countries.

<sup>\*</sup> See page 48 for action on date for Schizomycetes.

- (d) To indicate, if possible, by the formation or ending of the name the affinities or analogies of the genus
- (e) To avoid adjectives used as nouns.
- (f) Not to give a genus a name whose form is rather that of a subgenus or section (e.g. Eusuderarylon, a name given to a genus of Lauraceae. This, however, being legitimate, cannot be altered).
- (g) Not to make names by combining words from different languages (nomina hybrida).
- 4. Names of Species (binary names).

Art. 27. Names of species are binary combinations consisting of the name of the genus followed by a single specific epithet. If an epithet consists of two or more words, these must either be united into one or joined by a hyphen. Symbols forming part of specific epithets proposed by Linnaeus must be transcribed.

The specific epithet, when adjectival in form and not used as a substantive, agrees with the generic names.

Recommendations.

XIII. The specific epithet should, in general, give some indication of the appearance, the characters, the origin, the history or the properties of the species. If taken from the name of a person it usually recalls the name of the one who discovered or described it, or was in some way concerned with it.

XIV Names of men and women, and also of countries and localities used as specific epithets, may be substantives in the genitive (Clusia, saharae) or adjective (Clusianus, daharaeus). It will be well, in the future, to avoid the use of the genitive and the adjectival form of the same epithet to designate two different species of the same genus e.g. Lysimachia Hemsleyana Maximum. (1891), and L. Herisleyi Franch. (1895).

- XV. In forming specific epithets botanists will do well to have regard also to the following recommendations:
  - (a) To avoid those which are very long and difficult to pronounce.
  - (b) To avoid those which express a character common to all, or nearly all, the species of a genus.
  - (c) To avoid using the names of little-known or very restricted localities, unless the species is quite local.
  - (d) To avoid, in the same genus, epithets which are very much alike, especially those which differ only in their last letters
  - (e) Not to adopt unpublished names found in travellers' notes or in herbaria,
  - attributing them to their authors, unless these have approved publication.

    (f) Not to name a species after a person who has neither discovered, nor de-
  - scribed, nor figured, nor in any way studied it.
    (g) To avoid emthets which have been used before in any closely-allied genus.
  - (h) To avoid specific epithets formed of two or more (hyphened) words.
  - (i) To avoid epithets which have the same meaning as the generic name (pleonasm).

### Section 5. Conditions of Effective Publication (Art. 36)

Art. 36. Publication is effected, under these Rules, either by sale or distribution of printed matter or indelble autographs to the general public, or to specified representative botanical institutions.

No other kind of publication is accepted as effective: communication of new names at a public meeting, or the placing of names in collections or gardens open to the public, does not constitute effective publication.

## Section 6. Conditions and Dates of Valid Publication of Names (Art. 37-45, Rec. XXI-XXIX)

Art. 37. A name of a taxonomic group is not validly published unless it is both (1) effectively published (see Art. 36), and (2) accompanied by a description of the group or by a reference to a previously and effectively published description of it.

Art 38. From January 1, 1935, names of new groups of recent plants, the Bacteria excepted, are considered as validly published only when they are accompanied by a Latin diagnosis.

Art. 40. A name of a taxonomic group is not validly published when it is merely cited as a synonym.

Art. 42. A name of a genus is not validly published unless it is accompanied (1) by a description of the genus, or (2) by the citation of a previously and effectively published description of the genus under another name, or (3) by a reference to a previously and effectively published description of the genus as a subgenus, section or other subdivision of a genus

Art. 43. The name of a monotypic new genus based on a new species is validated (1) by the provision of a combined generic and specific description, (2) by the provision of a plate with analyses showing essential characters, but this applies only to plates and generic names published before January 1, 1908.

Art. 44. The name of a species or of a subdivision of a species is not validly published unless it is accompanied (1) by a description of the group, or (2) by the citation of a previously and effectively published description of the group under another name, or (3) by a plate or figure with analyses showing essential characters, but this applies only to plates or figures outlished before January 1, 1908

Art. 45. The date of a name or of an epithet is that of its valid publication (see Art 19, 36). For purposes of priority, however, only legitimate names and epithets published in legitimate combinations are taken into consideration (see Art 60). In the absence of proof to the contrary, the date given in the work containing the name or epithet must be regarded as correct.

Botanists will do well in publishing to conform to the following recommendations:

XXI. Not to publish a new name without clearly indicating whether it is the name of a family or a tribe, a genus or a section, a species or a variety, briefly, without expressing an opinion as to the rank of the group to which the name is given.

Not to publish the name of a new group without indicating its type (see Recommendation IV).

XXII. To avoid publishing or mentioning in their publications unpublished names which they do not accept, especially if the persons responsible for these names have not formally authorized their publication (see Recommendation XY (e)).

XXVI. To give the etymology of new generic names and also of new epithets when the meaning of these is not obvious

XXVII. To indicate precisely the date of publication of their works and that of the placing on sale or the distribution of named and numbered plants when these are accompanied by printed diagnoses. In the case of a work appearing in parts, the last published sheet of the volume should indicate the precise dates at which the different fascicles or parts of the volumes were published as well as the number of pages in each.

XXVIII. When works are published in periodicals, to require the publisher to indicate on the separate copies the date (year and month) of publication and also the title of the periodical from which the work is extracted XXIX. Separate copies should always bear the pagination of the periodical of which they form a part; if desired they may also bear a special pagination.

## Section 7. Citation of Authors' Names for Purposes of Precision (Art. 46-49, Rec. XXX-XXXII)

Art. 46. For the indication of the name (unitary, binary, or ternary) of a group to be accurate and complete, and in order that the date may be readily verified it is necessary to cite the author who first published the name in question.

Art. 47. An alteration of the diagnostic characters or of the circumscription of a group does not warrant the citation of an author other than the one who first published its name.

When the changes have been considerable, an indication of their nature and of the author responsible for the change is added, the words mutatis charact, or pro parte, or zzl. gen., ezzl. sp, ezzl. ar, or some other abridged indication being employed.

Art. 48. When a name of a taxonomic group has been proposed but not published by one author, and is subsequently validly published and ascribed to him (or her) by another author who supplied the description, the name of the latter author must be appended to the citation with the connecting word "ez."

If it is desirable or necessary to abbreviate such a citation, the name of the publishing author, being the more important, must be retained.

When a name and description by one author are published by another author, the word apud is used to connect the names of the two authors, except where the name of the second author forms part of the title of a book or periodical in which case the connecting word in is used instead.

Art. 49. When a genus or a group of lower rank is altered in rank but retains its name or epithet, the original author must be cited in parenthesis, followed by the name of the author who effected the alteration. The same holds when a subdivision of a genus, a species, or a group of lower rank is transferred to another genus or species with or without alteration of rank.

## Section 8. Retention of Names or Epithets of Groups which are Remodelled or Divided (Art. 50-52)

Art. 50. An alteration of the diagnostic characters, or of the circumscription of a group, does not warrant a change in its name, except in so far as this may be necessistated (1) by transference of the group (Art. 53-55), or (2) by its union with another croup of the same rank (Art. 56-57). or (3) by a change of its rank (Art. 58).

Art. 51. When a genus is divided into two or more genera, the generic name must be retained for one of them, or (if it has not been retained) must be re-established. When a particular species was originally designated as the type, the generic name must be retained for the genus including that species. When no type was designated, a type must be chosen according to the reculations which will be given (Appendix I).\*

Art. 52. When a species is divided into two or more species, the specific epithet must be retained for one of them, or (if it has not been retained) must be re-established. When a particular specimen was originally designated as the type, the specific epithet must be retained for the species including that specimen. When no type was designated, a type must be chosen according to the regulations to be given (Appendix I).

<sup>\*</sup> Appendix I has not been published as yet. See Type Basis Code, p. 61.

Section 9. Retention of Names or Epithets of Groups Below the Rank of Genus on Transference to Another Genus or Species (Art. 53-65)

Art. 53. When a subdivision of a genus is transferred to another genus (or placed under another generic name for the same genus) without change of rank, its subdivisional name must be retained, or (if it has not been retained) must be re-established unless one of the following obstacles exists (1) that the resulting association of names has been previously published validy for a different subdivision, or (2) that there is available an earlier validly published with-divisional name of the same rank

Art. 54. When a species is transferred to another genus (or placed under another generic name for the same genus), without change of rank, the specific epithet must be retained or (if it has not been retained) must be re-established, unless one of the following obstacles exists (1) that the resulting binary name has been previously and validly published for a different species, (2) that there is available an earlier validly published specific entitlet.

"When, on transference to another genus, the specific cpithet has been applied erroneously in its new position to a different plant, the new combination must be retained for the plant on which the epithet was originally based, and must be attributed to the author who first published it." (Accepted in this revised form at the Amsterdam Botanical Congress, 1935)

Art. 55 When a variety or other subdivision of a species is transferred, without change of rank, to another genus or species (or placed under another generic or specific name for the same genus or species), the original subdivisional epithet must be retained or (if it has not been retained) must be re-established, unless one of the following obstacles evists: (1) that the resulting ternary combination has been previously and validly published for a subdivision based on a different type, even if that subdivision is of a different rank; (2) that there is an earlier validly published subdivision is of a better translable.

When the epithet of a subdivision of a species, on transference to another species, has been applied erroneously in its new position to a different plant, the epithet must be retained for the plant on which the group was originally based.

Example. The variety micronihum Gren & Godf (Fl France, i, 171-1817) of Helinihimum italicum Pers, when transferred as a vanety to H penicillatum Tata, retains its varietal cpubet, becoming H penicillatum var micronihum (Gren. & Godr.) Grosser (in Fig.), Phantenerich, Helt 14, 115-1963)

#### Section 10 Choice of Names when Two Groups of the Same Rank are United, or in Fungs with a Picomorphic Life-cycle (Art. 58, 57, Rev. XXXIII-XXXV)

Art. 56. When two or more groups of the same rank are united, the oldest legitimate name or (in species and their subdivisions) the oldest legitimate cyribet is retained. If the names or explicit are of the same date, the author who unites the groups has the right of choosing one of them. The author who first adopts one of them, definitely treating another as a synonym or referring it to a subordinate group, must be followed.

Art. 57. Among Fungi with a pleomorphic life-cycle the different successive states of the same species (anamorphoses, status) can bear only one generic and specific name (binary), that is the estities which has been given, statuing from Fries, Systems, or Fries, Sympasis, to the state containing the form which it has been agreed to call the perfect form, provided that the name is otherwise in conformity with the fulles. The perfect state is that which ends in the ascess stage in the Ascongectics.

in the basidium, in the Basidiomyceles, in the teleutospore or its equivalent in the Uredinales, and in the spore in the Ustilaginales.

Generic and specific names given to other states have only a temporary value. The cannot replace a generic name already existing and applying to one or more species, any one of which contains the "perfect" form

The nomenclature of Fungi which have not a pleomorphic life-cycle follows the ordinary rules.

# Section 11. Choice of Names when the Rank of a Group is Changed

Art, 58. When a tribe becomes a family, when a subgenus or section becomes a secus, when a subdivision of a species becomes a species, or when the reverse of these changes takes place, and in general when a group changes its rank, the earliest legitimate epithet given to the group in its new rank is valid, unless that name or the resulting association or combination is a later homonym (see Art, 60, 61).

# Section 12. Rejection of Names (Art. 59-69, Rec. XXXVII)

- Art. 59. A name or cpithet must not be rejected, changed, or modified merely because it is badly chosen, or disagreeable, or because another is preferable or better known (see also Art. 69).
- Art. 60. A name must be rejected if it is illegitimate (see Art. 2) The publication of an epithet in an illegitimate combination must not be taken into consideration for purposes of priority, "except as indicated in Art. 61." (Added at the Amsterdam Botanical Congress, 1935.)
  - A name is illegitimate in the following cases:
- (1) If it was superfluous when published, i.e., if there was a valid name (see Art. 18) for the group to which it was applied, with its particular circumscription, position and rank.
- (2) If it is a binary or ternary name published in contravention of Art, 16, 50, 52, or 54, i.e., if its author did not adopt the earliest legitimate epithet available for the group with its particular erreumseription, postition, and rank
  - (3) If it is a later homonym (see Art. 61) (except as regards Art. 54 and 55).
  - (4) If it is a generic name which must be rejected under Art. 67.
  - (5) If its specific epithet must be rejected under Art. 68.
- Art. %). A name of a tavonomic group is illegitimate and must be rejected if it is a later homonym, that is, if it duplicates a name previously and validly published for a group of the same rank based on a different type. Even if the earlier homonym is illegitimate, or is generally treated as a synonym on tavonomic grounds, the later homonym must be rejected. "When an author simultaneously publishes the same new name for more than one group, the first author who adopts one of them, or substitutes another name for one of them, must be followed." (Added at the Amsterdam Botanical Congress. 1935.)
- Art. 62 A name of a taxonomic group must be rejected if, owing to its use with different meanings, it becomes a permanent source of confusion or error. A list of names to be abandoned for this reason (Nomina ambigua) will form Appendix IV.\*
- Art. 63. A name of a taxonomic group must be rejected when its application is uncertain (Nomen dubrum): c g. Errum soloniense L. (Cent. II. Pl. 28:1756) is a name the application of which is uncertain; it must, therefore, be rejected (see Schinz and Thell in Viertelphrissehr. Nat Ges. Zürich, vin. 71 1913).

<sup>\*</sup> Appendix IV has not been published as yet.

Art. 61. A name of a taxonomic group must be rejected if the characters of that group were derived from two or more entirely discordant elements, especially if those elements were erroneously supposed to form part of the same individual

A list of names to be abandoned for this reason (Namina confusa) will form Appendix VI.\*

Art, 65. A name or epithet of a taxonomic group must be rejected when it is based on a monstrosity

Art. 66. The name of an order, suborder, family or subfamily, tribe or subtribe must be changed when it is taken from the name of a genus which is known not to belong to the group in question-e c. if the genus Portulaca were excluded from the family now known as Partulacaceae, the residual group could no longer bear the name Portulacaccae, and would have to be renamed.

Art. 67. Names of genera are illegitimate in the following special cases and must

be rejected.

(1) When they are merely words not intended as names, e.g. Anonymous Walt. (Fl. Carol, 2, 4, 9, etc. 1788) must be rejected as being a word applied to 28 different genera by Walter to indicate that they were without names.

- (2) When they coincide with a technical term currently used in morphology unless they were accompanied, when originally published, by specific names in accordance with the binary method of Linnaeus On and after Jan. 1. 1912, all new generic names coinciding with such technical terms are unconditionally rejected.
- (3) When they are unitary designations of species e g Ehrhart (Photophologium: 1780; and Bestr. iv. 145-150 1795) proposed unitary names for various species known at that time under binary names; e.g. Phacocephalum for Schoenus fuscus, and Leptostachys for Carex leptostachys These names. which resemble generic names, should not be confused with them, and must be rejected, unless they have been published as generic names by a subsequent author.
- (4) When they consist of two words, unless these words were from the first combined into one, or soined by a hyphen

Art, 68. Specific epithets are illegitimate in the following cases and must be reiccted:

(1) When they are merely words not intended as names.

(2) When they are merely ordinal adjectives being used for enumeration.

(3) When they exactly repeat the generic name with or without the addition of a transcribed symbol.

(4) When they were published in works in which the Linnean system of binary

nomenclature for species was not consistently employed.

Art. 69 In cases foreseen in Art. 60-65 the name or epithet to be rejected is replaced by the oldest legitimate name, or (in a combination) by the oldest legitimate epithet. If none exists, a rew name or epithet must be chosen. Where a new epithet is required, an author may, if he nishes, adopt an epithet previously given to the group in an illegitimate combination, if there is no obstacle to its employment in the new preition or sense.

#### Section 13. Orthography of Names (Art. 70-71, tree XXXVIII-XLW)

Art. 70. The original spelling of a name or spathet must be retained, except in the ease of a typographic error, or of a clearly unintentional orthographic error. When the difference between two generic names lies in the termination, these names must

Appendix VI Lys not been published as yet.

be regarded as distinct, even though differing by one letter only. This does not apply to mere orthographic variants of the same name.

- Note 1. The words "original spelling" in this Article mean the spelling employed when the name was validly published.
  - 2. The use of a wrong connecting vowel or vowels (or the omission of a connecting vowel in a specific epithet, or in that of a subdivision of a species) is treated as an unintentional orthographic error which may be corrected (see Rec. XLIV). "The liberty of correcting a name must be used with reserve, especially if the change affects the first syllable, and above all the first letter of the name." (Added at the Amsterdam Botanical Congress, 1935.)
  - 3. In deciding whether two or more slightly different names should be treated as distinct or as orthographical variants, the essential consideration is whether they may be confused with one another or not: if there is serious risk of confusion, they should be treated as orthographic variants. Doubtful cases should be referred to the Executive Committee.
  - 4. Specific and other epithets of Greek origin differing merely by having Greek and Latin terminations respectively are orthographic variants. Epithets bearing the same meaning and differing only slightly in form are (considered as) orthographic variants. The genitive and adjectival forms of a personal name are, however, treated as different entitlets (or. J. Justanacha Hemslevana and L. Hemsleval.

# Recommendations:

XXXVIII. When a new name is derived from a Greek word containing the spiritus asper (rough breathing), this should be transcribed as the letter h.

XXXIX. When a new name for a genus, subgenus or section is taken from the name of a person, it should be formed in the following manner -

- (a) When the name of the person ends in a rowel the letter a is added (thus Boutelowa after Boutelou; Ottos after Otto; Sloanca after Sloanc), except when the name already ends in a, when ea is added (e.g. Collage after Colla).
- (b) When the name of the person ends in a consonant, the letters is are added (e.g. Magnusia after Magnus, Ramondia after Ramond), except when the name ends in er, when a is added (e.g. Kernera after Kerner).
- (c) The syllables which are not modified by these endings, retain their original spelling, even with the consonants k and w or with groupings of vowels which were not used in classical Latin. Letters foreign to botanical Latin should be transcribed, and diacritic signs suppressed. The Germanic a, δ, û become ac, oc, uc, the French t, δ, t become generally c. In works in which diphthongs are not represented by special type, the diacresis sign should be used where required, e.g., Cephallis, not Cephallis.
- (d) Names may be accompanied by a prefix or a suffix, or modified by anagram or abbreviation. In these cases they count as different words from the original name.

Examples: Durvillea and Urvillea; Lapeyrousea and Peyrousea; Englera, Englerastrum and Englerella; Bouchea and Ubochea; Gerardia and Graderia.

- XL. When a new specific or other epithet is taken from the name of a man, it should be formed in the following manner:-
  - (a) When the name of the person ends in a vowel, the letter i is added (thus Glazioui from Glaziou, Bureaui from Bureau), except when the name ends in a, when e is added (thus balansae from Balansa).

- (b) When the name ends in a consonant, the letters ii are added (thus Magnusii from Magnus, Ramondis from Ramond), except when the name ends in -er when i is added (thus Kerner).
- (c) The syllables which are not modified by these endings retain their original spelling, even with the consonants k or wo with groupings of vowels which were not used in classical Latin. Letters foreign to botaincal Latin should be transcribed and discritic signs suppressed. The Germanic a, δ, a become ac, oe, ou, the French k, b, b become generally e. The discress sign should be used where required.
- (d) When epithets taken from the name of a person have an adjectival form they are formed in a similar way (e.g. Geranium Robertianum, Verbena Hasslerana)
- XII. The same provisions apply to epithets formed from the names of women. When these have a substantival form they are given a feminine termination (e.g. Cypripedium Hookerae, Rosa Beatries, Scadiosa Olgae, Omphalodes lucities).
- XLII. The specific (or other) epithets should be written in conformity with the original spelling of the words from which they are derived and in accordance with the rules of Latin and Istinization.

Examples silvestris (not sylvestris) sinensis (not chinensis).

XLIII. Specific (or other) epithets should be written with a small initial letter, except those which are derived from names of persons (substantives or adjectives), or are taken from generie "or vernacular" names (substantives or adjectives). (Emended Amsterdam Botanical Congress, 1935. See page 61 for actions taken by Second International Microbiological Congress, London, 1936 governing Bacteriological Nonpenfature.)

NLIV. In the formation of specific (or other) epithets composed of two or several roots taken from Latin or Greek, the wone placed between the two roots becomes a connecting vowel, in Latin i, in Greek o, thus menthifolia, salitfolia, not menthasfolia, salitfolia. When the second root begins with a vowel and euphony requires, the connecting words should be climinated by a free free trained only where this is required for etymological reasons (e.g. carica-formis from Gartea, in order to a void confusion with carricformis from Gartea, in for the first of the compounds of Greek words no connecting vowel is required, e.g. brachycarpus and adverbability.

### Section 14. Gender of Generic Names

- Art. 72. The gender of generic names is governed by the following regulations:-
- (1) "A Greek or a Latin word adopted as a generic name returns its classical gender. In cases where the classical gender varies, the author has the right of choice between the alternative genders. In doubtful cases, general usage should be followed." "The following names, however, whose classical gender is masculue, are treated as feminine in accordance with historic usage: Adonis, Orchis, Stachys, Diospyros, Strychnos. Hemcrocallis (m. in Sp. Ph. Lat. and Gr. hemcrolles n) is also treated as feminine to bring it into conformity with all other generic names ending in st." (Emended Amsterdum Botanica) Congress, 1935.) See Van Esstline, Jour. Bact., 26, 1933, 509. for discussion of the gender of generic names used for bacteria.
  - (2) Generic names which are modern compounds formed from two or more Greek or Latin words take the gender from the last. If the ending is altered, however, the gender will follow it.
- (3) Arbitrarily formed generic names or vernacular names used as generic names take the gender assigned to them by their authors. Where the original

author has failed to indicate the gender, the next subsequent author has the right of choice.

Section 15. Various Recommendations (Rec. XLV-L)

XLV. When writing in modern languages botanists should use Latin scientific names or those immediately derived from them, in preference to names of another kind or origin (popular names). They should avoid the use of the latter unless these are very clear and in common use.

XLVII. Only the metric system should be used in botany for reckoning weights and measures. The foot, inch, line, pound, ounce, etc., should be rigorously evaluded from scientific language.

Altitude, depth, rapidity, etc., should be measured in meters. Fathoms, knots, miles, etc., are terms which should disappear from scientific language.

XLVIII. Very minute dimensions should be reckened in  $\mu$  (micromillimeters, microns, or thousandths of a millimeter) and not in fractions of millimeters or of lines, etc. fractions encumbered with eiphers and commas easily give rise to mistakes.

XLIX. Authors should indicate clearly and precisely the scale of the figures which they publish.

L. Temperatures should be expressed in degrees of the centigrade thermometer of Celsus.

Chapter IV. Interpretation and Modification of the Rules (Art. 73, 74)

Art. 73. A small permanent International Executive Committee is established with functions including the following:

(1) Interpreting the Rules in doubtful cases, and issuing considered "Opinions" on the basis of the evidence submitted.

(2) Considering Nomina conservanda, Nomina ambigua, Nomina dubia and Nomina confusa, and making recommendations thereon to the next International Botanical Concress

(3) Considering all proposals for the modification of the Rules and reporting thereon to the next Congress.

(4) Reporting on the effects of modifications of the Rules accepted at the preceding Congress.

Art. 74. These Rules can be modified only by competent persons at an International Botanical Congress convened for the express purpose. Modifications accepted at one Congress remain on trad until the next Congress, at which they will receive sanction unless undesirable consequences, reported to the Executive Committee, show need for further amendment or rejection.

Eight appendices have been or are to be prepared for this Code as follows: (1) †Regulations for determining types, (2) †Nomina conservanda familiarum, (3) \*Nomina generica conservanda, (4) †Nomina ambigua, (5) †Nomina dubia, (6) †Nomina confusa, (7) \*Representative botanical institutions recognized under Art. 34, (8) †Nomenclature of garden plants.

Unfortunately the first appendix which is of greatest interest to bacteriologists has not been prepared. As many bacteriologists, especially those in other countries, have not caught the significance of the type species

<sup>\*</sup>These appendixes have been prepared.

<sup>†</sup> These appendixes have not been published as yet.

concept as a means of defining bacterial genera, the reader is referred to the writings of Hitchcock (Amer. Jour. Bot., 8, 1921, 251; Descriptive Systematic Botany, New York, 1925) for an excellent exposition of the value of this idea to systematists.

Hitchcock (1921, p. 252) explains this concept briefly as follows: "The old concept was that a genus was a group of species having a given combination of characters; a species, similarly, a group of specimens. The new type concept is that, from the nomenclatural standpoint, a genus is a group of species allied to the type species; a species, a group of individuals similar to the type specimen."

Rules for determining types taken from the Type Basis Code of Nomenclature (Science, 49, 1919, 333, 53, 1921, 312) drawn up by a Committee of which Hitchcock was Chairman are quoted as these are the most authoritative rules thus far available.

# Type Basis Code of Nomenclature (Hitchcock et al.)

Article 4. The nomenclatural type species of a genus is the species or one of the species included when the genus was originally published.

If a genus included but one species when originally published, this species is the type.

When more than one species is included in the original publication of the genus, the type is determined by the following rules

(a) When, in the original publication of a genus, one of the species is definitely designated as type, this species shall be accepted as the type regardless of other considerations.

If typicus or typus is used as a new specific name for one of the species, this species shall be accepted as the type as if it were definitely designated

(b) The publication of a new generic name as an avowed substitute for an earlier

synonym, that species is to be accepted as the type.

(d) If a genus, when originally published, includes more than one species, and no species is definitely designated as type, nor indicated according to (c), the choice of the type should accord with the following principles.

 Species inquirendae or species doubtfully referred to the genus, or mentioned as in any way exceptional are to be evoluded from consideration in selecting the type

2 Genera of the first edition of Linnaeus's "Species Plantarum" (1753) are usually typifed through the citations given in the fifth edition of his "Genera Plantarum" (1751) except when inconsistent with the preceding

articles

#### RECOMMENDATIONS

Article 5. In the future it is recommended that authors of generic names definitely designate type species; and that in the selection of types of genera previously published, but of which the type would not be indicated by the preceding rules, the following points be taken into consideration:

(a) The type species should usually be the species or one of the species which the author had chiefly in mind. This is often indicated by

- 1. A closer agreement with the generic description.
- 2. Certain species being figured (in the same work).
- 3. The specific name, such as vulgaris, communis, medicinalis or officinalis.

(b) The type species should usually be the one best known to the author. It may be assumed that an indigenous species (from the standpoint of the author), or an economic species, or one grown in a botanical garden and examined by the author, would usually represent an author's idea of a genus.

(c) In Linnaean genera the type should usually be chosen from those species included in the first technical use of the genus in pre-Linnaean literature.

(d) The types of genera adopted through citations of non-binomial literature (with or without change of name) should usually be selected from those of the original species which received names in the first binomial publication.

(e) The preceding conditions having been met, preference should be shown for a species which will retain the generic name in its most widely used sense, or for one which belongs to a division of the genus containing a larger number of species, or, especially in Linnacan genera, for the historically oldest species.

(f) Among species equally eligible, the preference should be given to the first known to have been designated as the type.

(g) If it is impossible to select a type under the conditions mentioned above, the first of equally eligible species should be chosen.

While the rules and recommendations of the above botanical codes are applicable in general to bacteria and related microorganisms, the fact that these are not infallible is evident because the rules developed independently by zoologists (see Proc. Biol. Soc. Washington, 39, 1926, 75, for the latest Code of Zoological Nomenclature) frequently follow a quite different course. In some cases at least the zoological rules will appeal to microbiologists as more likely to produce uniformity of usage than the botanical rules.

For example, microbiologists assembled at the Second International Microbiological Congress in London, 1936 accepted (Jour. Bact., 33, 1937, 445) Art. 13 of the International Rules of Zoological Nomenclature as preferable to Rec. 43 of the Botanical Rules to govern bacteriological practice. This reads as follows: "While specific substantive names derived from names of persons may be written with a capital initial letter, all other specific names are to be written with a small initial letter. Some examples taken from bacteriological literature are: Salmonella Schottmuelleri or Salmonella schottmuelleri, Bacillus Welchii or Bacillus welchii, Acetobacter Pasteurianum or Acetobacter pasteurianum, Crynebacterium ovis, Nitrosomoras javanensis. Rhizobium japonicum."

In the Manuar all species names are written with a small letter. It is felt that the value of a name as a name is lessened if capitals or other marks are used to indicate etymology. The derivation of generic and specific names is given separately in the describitive material.

Likewise for obvious reasons, microbiologists refused (Jour. Bact., 33, 1937, 445) to follow the botanical and zoological practice which permits the use of duplicate generic names, one for an animal and the other for a plant group; and accepted the following rules to govern their practice.

"a. Generic homonyms are not permitted in the group Protista

b. It is advisable to avoid homonyms amongst Protista on the one hand, a plant or animal on the other."

The following actions of the International Committee on Bacteriological Nomenclature (Cent. f. Bact., II Abt., 92, 1935, 481) were confirmed (Jour. Bact., 93, 1937, 445).

Bacillus Cohn 1872 was accepted as a genus conservandum with Bacillus subtilis Cohn emend. Prazmowski 1880 as type species. It was agreed that Bacillus should be defined so as to exclude bacterial species which do not form endospores; and that the so-called Marburg strain found in type culture collections should be accepted as the type or standard strain.

At the Third International Congress of Microbiology held in New York City in September, 1939, a series of recommendations of the Permanent International Committees on Bacteriological Nomenclature were accepted at the plenary session of the Congress. The third and fourth recommendations were:

 That the Nomenclature Committee, as at present constituted, shall continue to function under the auspices of the International Association of Microbiologists as it did under the International Society for Microbiology.

4. That the International Committee shall select from its membership a Judicial Commission consisting of twelve members, evclusive of members rz officio, and shall designate a Chairman from the membership of the Commission. The two Permanent Secretaries of the International Committee on Bacterological Nomenclature shall be embers ex officio of the Judicial Commission. The Commissioners shall serve in three classes of four commissioners each for nine years, so that one class of four commissioners shall return at every International Congress. In case of the resignation or death of any Commissioner, his place shall be filled for the unexpired term by the International Committee at its next meeting.

By prompt action at and subsequent to the Congress ballots were east in spite of war conditions by 26 of the 62 members of the Permanent Committee on Nomenclature. These ballots when examined by the joint Secretaries of the Permanent Committee in November, 1942 were found to have resulted in the selection of the persons whose names appear below. These are grouped in the three classes specified by the Permanent Committee, those receiving the highest number of votes being placed in the nine year class, those receiving the next highest in the six year class, etc. Names in the classes are arranged alphabetically.

Elected for nine years.—(The term normally expires in 1948.) R. E. Buchanan (U.S.A.), A. J. Kluyver (The Netherlands), E. G. D. Murray (Canada), S. Orla Jensen (Denmark): Elected for six years.—(Term normally expires in 1945.) J. Howard Brown (U.S.A.), A.-R. Prévot (France), J. Ramsbottom (Great Britain), Th. Thjötta (Norway); Elected for three years.—(Term normally would have expired in 1942.) A. Lwoff (France), R. Renaux (Belgium), A. Sordelli (Argentine), C. Stapp (Germany).

This announcement was made (Sci., 97, 1943, 370) in the hope that some plan for taking tentative action on questions of nomenclature could be developed by those members of the Commission who could be reached under war conditions.

While no provision was made in 1939 for the contingencies that have arisen, it is felt that those elected should serve until successors are elected. Professor R. E. Buchanan has been asked to act as Chairman pro tem of the Judicial Commission as there is no possibility of securing an election under the rules as adopted.

Tentative International Rules of Bacteriological Nomenclature were presented to the Third International Congress of Microbiology by a U.S.A.-Canadian Committee on Compilation of Proposals on Bacteriological Nomenclature. As it proved impossible to give adequate consideration to these proposals during the Congress, the following recommendations of the Permanent Committee on Nomenclature were accepted:

1. That a recognized Bacteriological Code be developed.

2. That publication of such a proposed Code, when developed, be authorized with the proviso that it shall be regarded as wholly tentative, but in the hope that it shall be widely tested so that it may be brought up for further consideration and final disposition at the next Microbiological Congress which should normally take place in 1942.

Copies of this tentative Code have been issued in mimeographed form by Prof. R. E. Buchanan, Iowa State College, Ames, Iowa, U.S.A., Chairman of the U.S.A.-Canadian Committee and may be obtained from him.

## CLASS SCHIZOMYCETES NÄGELI

(Bericht Verhandl, d. bot. Section d. 33 Versammling deutsch, Naturforsch, u. Arzt. Bot. Ztg., 1857, 760)

Synonyms: Bacteria Cohn, Beitr. Biol d. Pflanzen, 1, Heft 1, 1872, 136; Bacteriaceae Cohn, ibid., 237; Bacteriales Clements (as an ordinal name), The Genera of Fungi. Minneapolis, 1909, 8. Schizomycetaceae De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 923; Schizomycetacea Castellani and Chalmers, Manual of Tropical Medicine, 3rd ed., 1919, 924, Mychota Enderlein, Bakteriencyclogenie, 1924, 236; Schizomycetae Stanier and Van Niel, Jour Bact , 42, 1941, 458.

Typically unicellular plants Cells usually small, sometimes ultramicroscopic. Frequently motile. As in the closely related blue-green algae (Class Schizophyceae). the cells lack the definitely organized nucleus found in the cells of higher plants and animals. However, bodies containing chromatin which may represent simple nuclei are demonstrable in some cases Individual cells may be spherical; or straight. curved or spiral rods. These cells may occur in regular or irregular masses or even in cysts. Where they remain attached to each other after cell division, they may form chains or even definite filaments. The latter may show some differentiation into holdfast cells, and into motile or non-motile reproductive cells (conidia) Some grow as branching mycelial threads whose diameter is not greater than that of ordibary bacterial cells, i.e., about one micron Some species produce pigments. The true purple and green bacteria possess pigments much like or related to the true chlorophylls of higher plants. These pigments have photosynthetic properties The phycocyanin found in the blue green algae does not occur in the Schizomycetes Multiplication is typically by cell division. Endospores are formed by some species included in Eubacteriales. Sporocysts are found in Myzobacteriales Ultramicroscopic reproductive bodies are found in Borrelomycetaceae. The bacteria are freeliving, saprophytic, parasitic or even pathogenic. The latter types cause diseases of either plants or animals. Seven orders are recognized.

# Key to the Orders and Sub-Orders of the Class Schizomycetes.

A. Cells rigid, not flexuous. Motility by means of flagella or by a gliding movement, 1. Cells single, in chains or masses. Not branching and mycelial in character. Not arranged in filaments. Not acid-fast. Motality when present by means of flagella.

Order I. Eubacteriales, p. 66.

- a. Do not possess photosynthetic pigments Cells do not contain free sulfur. b. Not attached by a stalk. Do not deposit ferric hydroxide. Sub-Order I. Eubacterimeae, p. 67.
  - bb. Attached to substrate, usually by a stalk. Some deposit ferric bydroxide
- Sub-Order II. Caulobacterimeae, p. 827. an. Possesses photosynthetic chlorophyll-like pigments. Some cells contain
  - free sulfue.

Organisms forming elongated usually branching and mycelial cells. Multiply by cell division, special spores, oidiospores and conidia. Sometimes acid-fast. Non-motile.

Order II. Actinomycètales, p. 895.

Cells in filaments frequently enclosed in a tubular sheath with or without a deposit of ferric hydroxide. Sometimes attached. Motile flagellate and non-motile conidia. Filaments sometimes motile with a gliding movement. Cells sometimes contain free sulfur.

Order III. Chlamydobacteriales, p. 981.

B. Cells flexuous, not rigid.

1. Cells elongate. Motility, by creeping on substrate

Order IV. Myzobacteriales, p. 1005.

2. Cells spiral. Motility, free swimming by flexion of cells.

Order V. Spirochaetales, p. 1051.

Supplements: Groups whose relationships are uncertain.

- 1. Obligate intracellular parasites or dependent directly on living cells.
  - Not ultramicroscopic and only rarely filterable. More than 0.1 micron in diameter.

Group I. Order Rickettsiales, p. 1083,

aa. Usually ultramicroscopic and filterable. Except for certain pox viruses of animals and a few plant viruses, less than 0.1 micron in diameter.

Group II. Order Virales, p. 1128.

Grow in cell-free culture media with the development of polymorphic structures including rings, globules, filaments and minute reproductive bodies (less than 0.3 micron in diameter).

Group III. Family Borrelomycetacege, p. 1201.

#### ORDER I. EUBACTERIALES BUCHANAN.

(Jour. Bact., £, 1917, 162.)

Simple and undifferentiated rigid cells which are either spherical or rod-shaped. The rods may be short or long, straight or curved or spiral. Some groups or species are non-mottle, others show locomotion by means of flagella. Elongated cells divide by transverse fission and may remain attached to each other in chains. Spherical organisms divide either by parallel fission producing chains, or by fission alternating in two or three planes producing thus either tetrads or cubes of 8 and multiples of 8 cells. Many spherical cells form irregular masses in which the plane of division cannot be ascertained. Endospores occur in some species. Some species are chromogenic, but only in a few is the pigment photosynthetic (bacteriochlorophyll or other chlorophyll-like pigments).

A group of rather large, spherical to short rod-shaped, colorless sulfur bacteria, which some feel should be included in the order Eubacteriales, has been attached as an Appendix to the order Chlamydobacteriales on account of the physiological similarity between the former organisms and the Beggiatoaceae. These are in Family Achromatiaceae, p. 997.

# SUB-ORDER I Eubacterlineae Breed, Murhay and Hitchens. (Jour. Bact., 47, 1944, 421.)

These are, as the name Eudacternace implies, the true bacteria in the narrower sense of the word The cells are rigid and free. Branching occurs only under abnormal conditions of life They are not attached by holdfasts nor stalks They form no sheaths. One-third of the species form pigments, but these have no photosynthetic properties Endospores occur in one family (Bacillaceae), rarely in others

Key to the Families of the Sub-Order Eubacterlineae.

# I, No endospores (except Sporosarcina)

- A. Can develop on morganic media Autotrophic and facultative autotrophic. Family I. Nitrobacteriaceae, p 69
- B. Cannot develop on morganic media (exceptions, see Family XII Bacteriaceae). Heterotrophic
  - 1. Polar flagellate, straight, curved or spiral rods Gram-negative. (Some species with a single flagellum will be found under Family IV Rhizobiaceae. Family V Micrococcaceae and Family VIII Corynebacteriaceae). Family II Pseudomonadaceae, p 82
  - 2. Large, oval, pleomorphic cells sometimes almost yeast-like in appearance Free hving in soil Fix free nitrogen. Peritrichous flagellation
  - Family III Azotobacteriaceae, n. 219 3. Peritrichous or non-motile rods, and eccei.
  - a Heterotrophic rods which may not require organic nitrogen for growth. Usually motile with one to six or more flagella. Usually form nodules or tubercles on roots of plants, or show violet chromogenesis.

Family IV Rhizobiaceae, p 223

- as Heterotrophic rods or cocci which utilize organic nitrogen and usually carbohydrates
  - b Spherical cells in masses, tetrads, and packets. A few species are motile with one or two flagella.
    - c. Gram-positive to Gram-negative cocci. Not obligate narasites. Family V. Micrococcaceae, p. 235.
    - ce Gram-negative, and sometimes anaerobic coces Obligate parasites

Family VI. Neisseriaceae, p 295.

- hb Spherical cells which grow in pairs and chains, and rods e Gram-positive cocci and rods Non motile (some species of Streptococcaceae or Corynebacteriaceae may show motility).
  - d Microaerophilic to anaerobic cocci and rods. Frequently in chains. Active in the fermentation of sugars. Never reduce nitrates
    - Family VII. Lactobacteriaceae, p. 305.
  - dd Usually aerobic, but sometimes annerobic rods. Less active in the fermentation of sugars. May or may not reduce nitrates.

Family VIII. Corynebacteriaceae, p. 381

- cc. Gram-negative rods. When motile, from four to many peritrichous flagella.
  - d. Grow well on ordinary media containing peptone. Aerobic to facultative anaerobic.
    - e. Gram-negative, straight rods which ferment sugars with the formation of organic acids.
      - f. Produce little or no acid in litmus milk. May or may not reduce nitrates. Many yellow chromogens. Borderline between this and following family indistinct. Some species anaerobic.
      - Family IX. Achromobacteriaceae, p. 412. ff. Produce CO, and frequently visible gas (CO, + H2) from glucose. Reduce nitrates. Usually from the alimentary, respiratory or urinary tract of vertebrates, though some are free-living or even

plant parasites. Family X. Enterobacteriaceae, p. 443.

dd. Small Gram-negative rods. Obligate parasites which usually require body fluids for growth. Do not grow well on ordinary media. Some are anaerobic.

Family XI. Pariobacteriaceae, p. 545. ccc. Rods of varied types not included in above families. Aerobic to facultative anaerobic.

Family XII. Bacteriaceae, p. 596. Il Form endospores. Large rods, sometimes in chains. Aerobic to anaerobic. Family XIII. Bacillaceae, p. 704.

#### \*FAMILY I. NITROBACTERIACEAE BUCHANAN

(Jour. Bact., 2, 1917, 319 and Jour. Bact., 3, 1918, 179.)

Cells without endospotes. Rod-shaped or ellipsoidal except for one spherical species (Nitroscoccus nitrosus). Spiral rods in Nitroscopira and in one species of Tribobaciflus. Tagella ether polar (so far as known), or absent. Gram stain uncertain, but presumably Gram-negative for all of the polar flagellate, rod-shiped species except for Nitroscomonas monocella which is reported to be Gram-positive. Capable of growing nithout organic compounds, using CO<sub>3</sub> as the source of carbon, and obtaining their energy by oxidation of ammonia, nitrite, hydrogen, sultur, or thiosulfate. Some species can also utilize organic compounds. Non-parasitic, usually soil or water forms

#### Key to the tribes and genera of family Nitrobacteriaceae.

 Organisms exidize ammonia to mitrite, or nitrite to nitrate. Growth on standard media very poor or absent.

Tribe I. Netrobactericae, p 70.

a. Cells avidize ammonia to mitrite
 b. Cells are separate, free or in dense aggregates
 Do not form roogloca.

c. Cells ellipsoidal

Genus I. Nitrosomonas, p. 70.

cc. Cells spiral.

Genus II. Natrosococcus, p. 71.

Genus III. Nitrosospira, p. 71.

bb. Cells form a roogloca

c. The zoogloca is surrounded by a common membrane forming a cyst.

Genus IV Nitrosocystis, p. 72.
cc. The massed cells are embedded in slime. No common membrane

gurrounds the cells

Genus V. Nitrosogloca, p. 73.

aa. Cells oxidize nitrite to nitrate

b. Cells form no roogloes

Genus VI Nitrobacter, p. 74.

bb. Cells form a roogloen

Genus VII. Astrocystis, p. 75

It. Organisms oxidise hydrogen.

n. Tribe II - Hydrogenomona leae, p. 76 -

a Aerobic, non-spore forming rods with single polar flarellum, or non-mobile Genus L. Hydrogenomonas, p. 76

<sup>\*</sup>Text revised by Prof. R. S. Breed and Prof. R. J. Gono, Genesia, N. V., Dec., 1937. Completely revised by Pr. R. L. Starkey, New Jersey Agricultural Experiment Station, New Hunnwick, N. J., March, 1931.

- C. Organisms oxidize sulfur or thiosulfate and similar inorganic compounds of sulfur.
  - Tribe III. Thiobacilleae. p. 78.
  - a. Aerobic to anaerobic, non-spore-forming rods with a single polar flagellum on each (so far as known), or non-motile.

Genus I. Thiobacillus, p. 78.

#### TRIBE I. NITROBACIERIEAE WINSLOW ET AL.

(Jour. Bact., 5, 1920, 201.)

Organisms deriving energy from the oxidation of ammonia to nitrite or from nitrite to nitrate and depend on this oxidation for growth. Fail to grow on media containing organic matter in the absence of the specific inorganic materials used as sources of energy. Many organic compounds commonly used in standard culture media are toxic to this group.

### Genus I. Nitrosomonas Winogradsky.

(Nitromonas Winogradsky, Ann. Inst. Past., 4, 1890, 257; Arch. Sci. biol., St. Petersburg, 1, 1892, 127; emend. S. and H. Winogradsky, Ann. Inst. Past. 50, 1933, 350)

Cells ellipsoidal, non-motile or with a single polar flagellum, occurring singly, in pairs, short chains or irregular masses, which are not enclosed in a common membrane. Oxidize ammonia to nitrite more rapidly than the other genera of this tribe. From Latin, nitrosus, full of soda; M.L. nitrous; and Greek monas, a unit; M.L. a monad.

The type species is Nutrosomonas europaea Winogradsky.

 Nitrosomonas europaea Winogradky. (Arch. Sci. biol., St. Petersburg, I, 1892, 127; Bacterium nitrosomonas Lehmann and Neumann, Bakt. Diag., 2nd ed., 9, 1899, 187; Pseudomos europaea Migula, in Engler and Prantl, Dio natürl. Pilanzenfam, I, 1a, 1895, 29; Planceoccus europaeus Vuillemin, Ann. Mycologie, Berlin, II, 1913, 525.) From Latin. europaeus. of Europe.

Rods: 0 9 to 1.0 by 1.1 to 1.8 microns occurring singly, rarely in chains of three to four. Possess a single polar flagellum 3 to 4 times the length of the rods, or rarely one at either end.

Grow readily in aqueous media without organic matter, and containing ammonium sulfate, potassium phosphate,
and magnesium carbonate. The cells
accumulate in soft masses around the
particles of magnesium carbonate at the
bottom of the flask. The liquid is occasionally turbid through development of
motile swarmer cells or monads.

Small, compact, sharply defined colonies brownish in color on silica gel. Aerobic.

Strictly autotrophic.

Source: Soils of Zurich, Switzerland; of Gennevilliers, France; and Kazan, Russia.

Habitat: Presumably widely distributed in soil.

- 1a. Nitrosomonas europaea var. italica Perotti (Rendic. d. Accad. d. Lincei Roma, 15, 1906, 516; Abs. in Cent. f. Bakt., II Abt., 19, 1907, 337). Also see Engel and Skallau (Cent. f. Bakt., II Abt., 97, 305, 1937).
- Nitrosomonas monocella Nelson. (Cent. f. Bakt., II Abt., 83, 1931, 287.)
   From Greek monos, single and Latin cella, room; M.L. single cell.

Ovoid rods: 0.6 to 0.9 micron, often occurring in pairs. Young cells nearly spherical. Motile by means of a single polar flagellum 3 to 5 times as long as the rod. Gram-positive (Nelson) Found negative by H. J. Conn (personal communication).

No growth in nutrient broth, nutrient agar, nutrient or plain gelatin, plain or litmus milk, glucose or plain yeast

water, or on potato.

Silica gel or agar plates of inorganic medium: No typical colonies, but yellowish brown masses of growth around particles of CaCO, in the medium

Inorganic liquid medium containing ammonium salts: Uniform development throughout the liquid as well as in the carbonate sediment.

Even low concentrations of organic matter retard or completely inhibit the initiation of growth. Plant extracts are toxic. Free CO<sub>2</sub> and O<sub>2</sub> necessary for growth. Optimum pH 8.0 to 9.0. Poor growth below pH 7.0. Some growth above pH 0.0

Optimum temperature for growth and oridation 25°C.

Aerobic.

Strictly autotrophic.

Source: Isolated from field soil.

Habitat: Presumably widely distributed in soil.

S Winogradsky and H. Winogradsky (Ann. Inst. Pasteur, 50, 1933, 391) have described 5 cultures of Witosomomas which were obtained from soils of France. An additional culture has been described by H. Winogradsky (Ann. Inst. Pasteur, 58, 1937, 391) from activated sludge.

# Genus 11 Nitrosococcus Winogradsky.

(Arch Sci. biol , St Petersburg, 1, 1892, 127.)

Ord Announced to altrite.

1. Nitrosococcus nitrosus (Migul+) Bergey et al. (Nitrosococcus Winogradsky, Ann. Inst. Pasteur, 6, 1891, 577, 
Arch. Sei. biol., St. Petersburg, 1, 1892, 
127; Micrococcus antrosus Migula, Syst 
d. Bakt., 2, 1900, 191; Nitrosococcus americanus Buchanan, Jour Bact., 3, 1918, 
180; Manual, 2nd ed., 1925, 35) From 
Latin, nitrous, full of soda, M. L. nitrous 
Large spheres, 1 5 to 17 microus in

size, with thick cell membrane. Motility could not be demonstrated Stains readily with aniline dyes. Observed no zoogloea formation. Gram-positive (Omelianski, Cent I. Bakt, II Abt., 19, 1907, 263)

Liquid medium Turbidity

Silica gel Both dark and light colonies Surface colonies look like small drops of a turbid yellowish liquid.

Aerobic.

Optimum temperature 20° to 25°C.

Source: Isolated from soil from Quito, Leundor; Companius, Brazil, Melbourne, Australia.

Habitat: Presumably widely distributed in soil

# Genus III. Nitrosospira Winogradsky.

(Compt. rend. Acad. Sci., Paris, 192, 1931, 1994; Ann. Inst. Pasteur, 59, 1933, 400.)

Cells spiral-shaped. Oxidize ammonia to nitrite very slowly. From Latin, nitrosus, full of sods; and spira, coil, spiral; M.L. nitrous spiral.

The type species is Nitrosospira briensis Winogradsky.

 Nitrosospira briensis Winogradsky (Ann. Inst. Pasteur, 50, 1933, 407.) From French, Brie, a place name; M.L. of Brie.

Spirals wound tightly to form very small cylinders as long as 15 to 20 microns. Short spirals have the appearance of short rods and ellipsoidal cells. Small pseudo-cocci were observed in old cultures.

Colonies on silica gel: Small colonies which occasionally contain cyst-like aggregates of cells. The cysts are more poorly developed than in Nitrosocystis.

Aerobic.

Reaction optimum: pH 7.0 to 7.2.

Source: Uncultivated pasture soil of Brie, France.

Habitat: Presumably widely distributed in soil.

 Nitrosospira antarctica Winogradsky. (Ann. Inst. Pasteur, 50, 1933, 407.)
 From Greek, antarkitos, southern, antarctic.

Cells and colonies similar to N. briensis except that the cells are generally wound together to form more compact spirals.

Aerobic.

Reaction optimum: pH 7.0 to 7.2 Source: Soil from the Antarctic.

Habitat: Presumably widely distributed in soil.

# Genus IV. Nitrosocystis Winogradsky.

(Compt. rend. Acad Sci., Paris, 193, 1931, 1003; Ann. Inst. Pasteur, 50, 1933, 399.)

Cells ellipsoidal or elongated, uniting in compact, rounded aggregates surrounded by a common membrane to form cysts. The cysts disintegrate to free the cells, particularly when transferred to fresh media. Within the cyst, the cells are embedded in slime. Oxidize ammonia to nitrite at a rate intermediate between Nitrosomonas and Nitrosospira. From Latin, nitrosus, full of soda; and Greek, kystis, bladder; M.L. nitrous cyst.

The type species is Nitrosocystis javanensis comb. nov.

1 Mitrosocystis javanensis comb. nov. (Nitrosomonas javanensis Winogradsky, Arch. Sci. bol, St. Petersburg, I, 1892, 127, Pseudomonas javanensis Migula, in Engler and Prantl, Die natur. Pflanzenfam, I, 1a, 1895, 30, Comptrend. Acad Sci, Paris, 182, 1931, 1003.) From Latin, of Java.

Small ellipsoidal cells having a diameter of 0 5 to 0.6 micron. Possess a polar flagellum 20 times as long as the rods

In liquid medium produces very compact zoogloeal masses of cells and motile swarmers. The large zoogloea are themselves composed of smaller compact aggregates of cells.

On silica gel the colonies are circular to elliptical becoming clear or light brown. Aerobic.

Strictly autotrophic.

Source: Soil of Buitenzorg, Java; Tokyo, Japan; La Reghaia, Tunisia. Habitat: Presumably widely distributed in soil.

 Nitrosocystis coccoides nom. nov. (Nitrosocystis a, S Winogradsky and H. Winogradsky, Ann. Inst. Pasteur, 50, 1933, 401.) From Greek, kokkos, a grain; eidos, form, shape; M.L. coccus-like.

Ellipsoidal cells about 1.5 microns in diameter. Occur as compact aggregates of cells imbedded in mucus and surrounded by a thickened capsule to form cyst-like bodies. Cells rarely solitary but more often in pairs and in small groups of four or more. Probably motile. The mucus which surrounds the cells is not readily stained, whereas the outside coating stains more easily.

Colonies on silica gel: As colonies develop, the coating of CaCO; on the gel becomes vellowish and dissolves and the colony appears as a bulbous, angular, brown body which may become 0.5 mm in diameter. The cells are held firmly together in these irregularly shaped bulbous aggregates.

Aerobic

Source: Poor soils of Brie and elsewhere in France.

Habitat: Presumably widely distributed in forest and manured soils

A similar culture called Nitrosocustis BA. was isolated from activated sludge by H. Winogradsky (Compt rend Acad Sci., Paris, 200, 1935, 1888; Ann. Inst Pasteur, 58, 1937, 326). It produced compact, bulbons, dented cyst-like aggregates of cells having a vellow color. The colonies produced clear zones on silica gel coated with CaCO: These cysts were composed of oval or elongated coccoid cells imbedded in mucus and surrounded by a thickened capsule, composed of two layers. The cells become dispersed from the eysts as motile cells and form new colonies. This culture differs from N. coccordes in that the colonies have a pale reddish vellow color and the oval cells are 0.5 by 1.5 microns in size.

Cultures of Nutresocustis were obtained by Rommell (Svensk, botan, Tidskrift, 26, 1932, 303) from forest soils. Kingma Bolties (Arch. f. Mikrobiol., 6, 1935, 79) obtained cultures which produced masses of cells, some of which were loose and others compact. They were not believed to be true zoogloes since no capsule or slimy substance was noted. The development of true eyets by nitrifying bacteria was questioned. Winogradsky (Bull. d l'Inst. Pasteur, 55, 1935, 1074) concluded that Kingma Bolties worked with a culture of Nitrospenstis and not of Nutrosomonas as was believed.

# Genus V. Nitrosogloea H. Winogradsky.

(Compt. rend. Acad Sci., Paris, 200, 1935, 1887; Ann. Inst. Pasteur, 58, 1937, 335.)

Cells ellipsoidal or rod-shaped Embedded in slime to form zoogloca. No common membrane surrounds the cells aggregates Oxidize ammonia to nitrite. From Latin. nurosus, full of soda; and Greek, gloca, glue, Jelly; M L. nitrous jelly.

The type species is Nitrosogloen merismoides H. Winogradsky.

1. Nitrosogioea merismoides II. Winogradsky, (Nitrosocustis "I", H. Winogradsky, Trans. Third Intern. Cong. Soil Sei., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann. Inst. Pasteur, 58, 1937, 333.) From Greek, merismos, a dividing, division; eidos, form, shape; M.L. division-like.

Ellipsoidal cells: 0.5 by 1.5 microns .Oval cells or short rods forming tetrads or chains, each group with its own sheath. The groups vary in shape to produce branched chains, irregular or compact aggregates.

Colonies on silica gel: Cells encased in a pale vellow mucilage giving the colony a dull appearance Colony surface studded with little humps.

Aerobic.

Source: Activated sludge Habitat: Unknown.

2. Nitrosogloca schizobacteroides II. Winogradsky. (Nitrosocystis "II", II. Winogradsky, Trans Third Intern. Cong. Soil Ser., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann Inst. Pasteur, 58, 1937, 333.) From Greek, schizo, to split; bakterion, a small rod; enlos, form, shape; M.L. like a dividing rod.

Rods: Clongated rods or short filaments 3 to 4 microns long.

Colonies on silica gel. Flat groups of cells are produced which are united in a common sheath. The aggregates form a pseudo-tissue of interwoven filaments suggestive of a fungus pad. The pad can be removed as a unit from the medium.

Aerobic.

Source: Activated sludge.

Habitat: Unknown.

3. Nitrosogloea membranacea Winogradsky. (Nitrosocystis "III", II. Winogradsky, Trans. Third Intern. Cong. Soil Sci., Oxford, 1, 1935, 139; Compt. rend. Acad. Sci., Paris, 200, 1935, 1887; Ann. Inst Pasteur. 58, 1937, 333.) From Latin, membranaceus, of skin membrane.

Ellipsoidal cells commonly in pairs and also solitary.

Colonies on silica gel; Appear as dull mucoid material with a pale straw color. The cells are held firmly together so that the entire colony is easily picked up with the transfer needle. No structural units within the colony.

Aerobic.

Source: Activated sludge. Habitat : Unknown.

Genus VI. Nitrobacter Winogradsky.

(Winogradsky, Arch. Sci. biol., St. Petersburg, 1, 1892, 127; Nitromonas Orla-Jensen, Cent f. Bakt , II Abt., 22, 1909, 331; not Nitromonas Winogradsky, Ann. Inst. Past., 4, 1890, 257; Nitrobacterium Castellani and Chalmers, Manual Trop. Med., 1919, 933.)

Cells rod-shaped. Oxidize nitrite to nitrate. From Latin, nitrum, soda; M.L. nitre; and Greek baltron, a small rod.

The type species is Nitrobacter winogradskyi Buchanan.

 Nitrobacter winogradskyi Buchanan. (Nitrobacter Winogradsky, Arch. Sci. biol., St. Petersburg, 1, 1892, 127; Bacterium nitrobacter Lehmann and Neumann, Bakt. Diag., 2nd ed., 2, 1899, 187; Bacillus nitrobacter Löhnis, Vorlesungen landw. Bakt , Berlin, 1913, 152; Buchanan, Jour. Bact., 3, 1918, 180; Nitrobacterium netrobacter Castellani and Chalmers, Manual Trop Med., 1919, 933.) Named for S. Winogradsky, 1856-, the Russian microbiologist, who first isolated these bacteria.

Description taken from Gibbs, Soil

Sci., 8, 1919, 448.

Short, non-motile rods with gelatinous membrane, 0.6 to 0.8 by 1.0 to 1.2 microns. Does not stain readily. Gramnegative (Omelianski, Cent. f. Bakt , II Abt., 19, 1907, 263.)

Can be cultivated on media free of organic matter. Sensitive to certain organic compounds.

Washed agar colonies. In 7 to 10 days very small, light brown, circular to irregular colonies, becoming darker.

Silica gel: Colonies smaller but more dense than on washed agar.

Washed agar slant: In 7 to 10 days scanty, gravish streak.

Inorganic solution medium: After 10 days flocculent sediment. Sensitive to ammonium salts under alkaline conditions.

Nitrite is oxidized to nitrate.

Aerobic.

Strictly autotrophic.

Optimum temperature 25° to 28°C. Source: Soil.

Habitat: Presumably widely distribnted in soil.

Nitrobacter agile Nelson. (Cent. f. Bakt., II Abt., 83, 1931, 287.) From Latin agile, quick, agile, motile.

Rods: 0 5 by 0.8 to 0 9 micron, occurring singly, sometimes in pairs or larger aggregates. Rapidly motile with a long. thin, polar flagellum often 7 to 10 times as long as the rod. (Non-motile culture obtained by Kingma Boltjes, Arch. f. Mikrobiol., 6, 1935, 79.) Gram-negative.

No growth in nutrient broth, nutrient agar, nutrient or plain gelatin, litmus or plain milk, glucose or plain yeast water, or on potato.

Nitrite agar: After two weeks, produces semi-spherical, minute, nearly transparent colonies. Oxidation usually complete in 10 to 14 days.

Inorganic liquid medium containing nitrite: Produces uniformly dispersed growth.

Optimum pH 7.6 to 86 Limits of growth 6.6 to 10.0

Temperature relations: Optimum for growth 25° to 30°C. Optimum for oxidation 28°C. No oxidation at 37°C. Thermal death point 60°C, for five minutes.

Strictly autotrophic.

Aerobic

Source: Isolated from greenhouse soils and from sewage effluents in Madison. Wisconsin.

Habitat: Presumably widely distributed in soil.

Genus VII. Nitrocystis II. Winogradsky.

(Trans Third Intern. Cong Soil Sci., Oxford, 1, 1935, 139; Nutrogloca H., Winogradsky. Comp. rend. Acad. Sci., Paris, 200, 1935, 1888.)

Cells ellipsoidal or rod-shaped Embedded in slime and united into compact zooglocal aggregates. Oxidize nitrite to nitrate. From Latin, nitrum, soda: M.L. nitre; and Greek, kustis, bladder, M.L. nitric cyst.

The type species is Natrocustis sarcinoides.

1. Nitrocystis sarcinoides H. Winogradsky. (Nitrocystis B. A., Winogradsky, H., Compt. rend Acad. Sci., Paris, 200, 1935, 1888; Nitrocystis "I" and "II", Winogradsky, H., Trans, Third Intern. Cong. Soil Sci , Oxford, 1, 1935, 139; Ann. Inst. Pasteur. 58, 1937, 336.) From Latin, sarcina, a packet; M.L. Sarcina, a genus: Greek, eidos, form, M.L. Sarcina-like.

Rods: Small rods 05 by 1.0 micron Cells ellipsoidal or wedge-shaped and grouped in sarcina-like packets

Colonies on silica gel: On the surface of gel coated with kaolin the colonies appear as small raised amber warts The colonies grow up to 5 mm in diameter The colonies are viscous and sticky when young and they become brown with age, shrink, and look like scales and become hard like grains of sand. Each colony is enveloped in several layers of a thick slime which holds the cells together so that the entire colony can be removed with a transfer needle.

Aerobic.

Source: Activated sludge. Habitat: Unknown.

2. Nitrocystis micropunctata H. Winogradsky. (Nitrocystis "III", Winogradsky, H., Trans Third Intern. Cong. Soil Sei., Oxford, 1, 1935, 139; Netrogloca micropunctata Winogradsky, H., Compt. rend, Acad. Sci., Paris, 200, 1935, 1888; Ann. Inst. Pasteur, 58, 1937, 326.) From Greek, mikros, small, little; and Latin. punctatus, spotted; M L. with small spots.

Cells are ellipsoidal rods about 0.5 micron in diameter which stain poorly except at the ends Encased in a viscous slime.

Colonies on silica gel Like N. sarcincides except that the colonies are more clear and they have a more plastic consistency. The cells are not held together by the slime in the colony as with N. sarcinoides. The capsule is more readi'y differentiated in old colonies

Aerobic.

Source: Activated sludge. Habitat: Unknown.

Appendix: The following have been placed in the Tribe Nitrobactericae, sometimes incorrectly so:

Bactoderma alba Winogradsky, (Ann.

Inst. Pasteur, 50, 1933, 414) From soil. This is the type species of genus Bactoderma Winogradsky.

Bactoderma rosea Winogradsky (loc. cit., p. 415). Isolated from soil.

Bacterum nitrificans Chester. (Nitratbildner aus Northeim, Burri and Stutzer, Cent. f. Bakt, II Abt., I, 1895, 735; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 94, Bacillus nitrificans Chester Man Determ Bact., 1901, 239; Achromobacter nitrificans Bergey et al., Manual, 1st ed., 1923, 137.) From soil. Description of this organism was shown by Winogradsky (Cent. f. Bakt., II Abt., 2, 1896, 415 and 449) to have been based on impure cultures.

Microderma minutissima Winogradsky. From soil. This is the type species of

genus Microderma Winogradsky.
Microderma vacuolata Winogradsky

(loc. cit.), Isolated from soil
Ni'rosobacillus thermophilus Campbell.

See Bacillus appendix.

Nitrobacter flavum Sack. (Cent. f.
Bakt., II Abt., 62, 1924, 20) Isolated
from garden earth See description,

Manual, 5th ed., 1939, 74. Heterotrophic and does not belong here (Kingma Boltjes, Arch. f. Mikrobiol., 6, 1935, 83).

Nitrobacter oligotrophum Beijerinek. (Folia Microbiol., 3, 1914, 91; Verzamelde Geschriften van M. W. Beijerinek, 5, 1922, 190.) Isolated from soil. On cultivation this species lost its autotrophic habit and became heterotrophic. The organism was then called Nitrobacter polytrophum Beijerinek.

Nitrobacter opacum Sack (loc. cit. p. 21). Source and relationships as above. See Manual, 5th ed., 1939, 75.

Nitrobacter punctatum Sack (loc. cit., p. 20). Source and relationships as above. 'See Manual, 5th ed., 1939, 75.

Netrobacter roseo-album Sack (loc. cit., p. 17; Serratia roseo-alba Bergey et al., Manual, 3rd ed., 1930, 125.) Source and relationships as above. See description, Manual. 5th ed., 1939, 74.

Nitrosomonas groningensis Sack. (Cent. I. Bakt., II Abt., 64, 1925, 34.) Source and relationships as above. See description, Manual, 5th ed., 1939, 77.

# TRIBE II. HYDROGENOMONADEAE PRIBRAM.

(Jour. Bact., 18, 1929, 370.)

Short rods, non-motile or with lophotrichous flagells. Organisms capable of deriving energy from exidation of hydrogen. They probably grow well on organic media without hydrogen, although this has not been shown to be true for all species.

## Genus I. Hydrogenomonas Orla-Jensen.\*

(Cent. f. Bakt., II Abt., 22, 1909, 311.)

As the only genus of the tribe, its definition is identical with the definition of the tribe. From Greek  $hyd\bar{o}r$ , water; genos, producing and monas, a unit.

The type species is Hydrogenomonas pantotropha (Kaserer) Orla-Jensen.

<sup>•</sup> This group of bacteria is characterized by the ability to grow in substrates containing no organic matter and to utilize elemental hydrogen as the source of energy for growth. Under these condutions CO, is used as the source of carbon. Bacteria with similar physiological characteristics but differing in morphology are placed in the genera Bacterium, Bactllus and Clostridium. Although other bacteria and even cernain algae have enzyme systems which can activate hydrogen and reduce CO, in the process, there is no evidence that these organisms are able to grow in inorganic media.

### Key to the species of genus Hydrogenomonas.

- A. Not sensitive to high O<sub>2</sub> concentrations Growth in solution media under autotrophic conditions characterized by turbidity without pelliele formation.
- Hydrogenomonas vantotropha.
   Sensitive to high O<sub>2</sub> concentrations Growth in solution media under autotrophic conditions characterized by policie adhering to walls of container.
- C. Sensitive to high O<sub>2</sub> concentrations Growth in solution media under autotrophic conditions without pellule formation.
  - 3 Hudrogenomonas flara.
- 1. Hydrogenomonas pantotropha (Kaserer) Orla-Jensen (Bacillus parlotrophus Kaserer, Cent f Bakt, II Abt, 16, 1966, 688, Orla-Jensen, Cont I. Bakt., II Abt., 22, 1909, 311) From Greek pantos, everything and trophos, feeds on: M.I. omnuyorous

Rods: 04 to 05 by 12 to 15 microns with rounded ends Occur singly, in pairs, and in chains. Encapsulated Actively motile by means of a single long polar flagellum. Gram stain not recorded. Binolar staining in old cultures

Inorganic solution: When cultivated under an atmosphere of O<sub>2</sub>, CO<sub>2</sub> and H<sub>2</sub>, the liquid becomes turbed without pellicle formation

Inorganic solid media. When cultivated under an atmosphere of O<sub>2</sub>, CO<sub>3</sub> and H<sub>3</sub>, the colonics are yellow and slimy, and the agar plates have an odor resembling hot stapy water.

Gelatin colonies: Yellow, smooth, rarely concentrically ringed or greenish Gelatin stab. Growth only at surface As a rule no liquefaction.

Agar colonies Same as on gelatin, greenish, often slimy.

greenish, often shmy.
Broth: Turbid, somewhat shmy, and

occasional pellicle
Milk: No congulation. A yellow pellicle forms. Medium becomes slimy and
assumes a dirty firsh color.

Potato: Maist, yellow, glistening.
Indicate is not formed.
Ifydrogen suifide is not formed.
Nitrite is not produced from nutrate
Does not act on carbohydrates.
Aerobic.

Optimum temperature 28° to 30°C. Facultative autotroph

Distinctive characters Develops autotrophically in inorganic medium under an atmosphere of H<sub>2</sub>, O<sub>2</sub> and CO<sub>2</sub> Oxidizes hydrogen to water and uses CO<sub>2</sub> as the source of carbon for growth.

Source. Isolated from soil near Vienna. Habitat. Probably widely distributed in soil.

 Hydrogenomonas vitrea Nikiewski. (Jahrb. f. wissensch. Botanik, 48, 1910, 113)
 From Latin vitreus, of glass, transparent.

Rods 2.0 microns in length, cells adhering to each other as by slime. Motility not observed.

Agar colonies on inorganic medium in presence of III, O3 and CO3. Delicate, transparent, with slight fluorescence, and yellow center. Surface folded. Do not develop readily beneath the surface of medium

Agar streak on inorganic substrate. Same as agar colonies except that growth as spreading.

Inorganic liquid medium in presence of II, O<sub>2</sub> and CO<sub>2</sub>. Pelliele, adherent to wall of tube. Good development when there is from 2 to 8 per cent oxygen in the gas. At linker O<sub>2</sub> concentrations good growth occurs only in association

with H. flara or other bacteria, Oxidizes hydrogen to water.

Microaerophilic, growing in an atmosphere of low oxygen tension, not exceeding 8 per cent.

l'acultative autotropic,

Distinctive characters: Grows in substrates containing no organic matter and

produces a pelliele.

Source: Isolated from mud. garden

soil, pasture land, vegetable mold, and peat.

Habitat: Presumably widely distrib-

3. Hydrogenomonas flava Niklewski. (Jahrb. f. wissensch. Botanik., 48, 1910, 113; emend. Kluyver and Manten, Antonie v. Leuwenhoek, 8, 1942, 71.) From Latin flavus. vellow.

Rods: 1.5 microns in length. Motility by polar flagella. Gram-negative.

Agar colonies on inorganic medium in presence of H<sub>2</sub>, O<sub>2</sub> and CO<sub>2</sub>: Small, smooth, yellow, shining, adhering to medium. Develop well below surface of medium, but growth is paler.

Gelatin not liquefied.

Inorganic liquid medium in presence of H<sub>2</sub>, O<sub>2</sub>, and CO<sub>2</sub>: No pellicle formation. Good development when there is from 2 to 8 per cent oxygen in the gas At higher O<sub>2</sub> concentrations good growth occurs

only in association with H. vitrea or other bacteria.

Oxidizes hydrogen to water.

Microaerophilic, growing in an atmosphere of low oxygen tension, not exceeding 8 per cent.

Facultative autotroph.

Distinctive characters: Found singly on slides whereas the rod-shaped cells of Hydrogenomonas vitrea tend to cling together in masses. Colonics on agar opaque, not transparent.

Source: Same as II, vitrea.

Habitat: Presumably widely distributed in soil.

Appendix: Incompletely described species are found in the literature as follows:

Hydrogenomonas agilis Niklewski. (Jubliaumsschrift f. Prof. E. Godlewski. Kosmos, Lemberg, 1913; See Cent. f. Bakt., II Abt., 40, 1914, 430.) From soil.

Hydrogenomonas minor Niklewski. (Jubliäumsschrift f. Prof. E. Godlewski. Kosmos, Lemberg, 1913; See Cent. f. Bakt., II Abt., 40, 1914, 431.) From soil.

TRIBE III, THIOBACILLEAE BERGEY, BREED AND MURRAY,

(Preprint, Manual, 5th ed., Oct., 1938, v.)

Organisms capable of deriving their energy from oxidation of sulfur or sulfur compounds. Most species do not grow on organic media.

#### Genus I. Thiobacillus Beijerinck.

(Beijerinek, Cent. f. Bakt., II Abt., 11, 1904, 593; Sulfomonas Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 314; not Thiobacilius Ellis, Sulphur bacteria, London, 1932, 130; Thiobacterium Lehmann and Neumann, Bakt. Diag., 7 Ausl., 2, 1927, 517; not Thiobacterium Janke, Allgemeine Tech. Mikrobiol., 1, 1924, 68, Leipzig)

Small Gram-negative, rod-shaped cells. Non-motile or motile by means of a single polar Bágellum Derive their energy from the ovidation of incompletely oxidized sulfur compounds, principally from elemental sulfur and thiosulfate but in some cases also from sulfide, sulfite, and polythionates. The principal product of oxidation is sulfate, but sulfur is sometimes formed. They grow under acid or alkalme conditions and derive their carbon from earbon dioxide or from blearbonates in solution; some are obligate and some facultative autotrophic. One species is facultative anaerobic. From Greek hielon, sulfur and Latin bacefilus, a small rod.

The type species is Thiobacillus thioparus Beijerinck.

# Key to the species of genus Thlobacillus.

- I. Aerobic.
  - A. Strictly autotrophic.
    - 1. Optimum reaction for growth close to neutrality.
      - Thiobacillus thioparus.
    - 2 Optimum reaction for growth pH 2.0 to 3.5.
      2. Thiobacillus thiooxidans.
  - B. Facultative autotrophic.
- 3. Thiobacillus novellus.
- 4. Thiobacillus coproliticus.
- II. Anaerobic in presence of mitrate.
- Thiobacillus denitrificans.

 Thiobacilius thioparus Beijerinek (Cent. I. Bakt., II Abt., 11, 1904, 593; Nathanson, Mitt. Zool Sintion Neapel, 15, 1902, 655; Sulfomenas thioparus Orla-Jensen, Cent. I. Bakt., II Abt., 22, 1900, 236). From Greek theion, sulfur and paro, to make

Thin, short rods, 0 5 by 1 to 3 0 microns. Motile (non-motile culture reported See Starkey, Soil Sci., 39, 1935, 197.) Gram-negative.

Thiosulfate medium (liquid) · Pellicle consisting of cells and free sulfur.

Thiosulfate agar. Colonies small, circular, whitish yellow due to precipitated sulfur.

Optimum reaction: Close to neutrality. Strictly autotrophic. Derives its energy by the oxidation of thiosulfate to

sulfate and sulfur; also oxidizes sulfur to sulfate.

Aerobic.

Source: Sea water, river water, mud, sewage, and soil.

Habitat: Presumably widely distributed.

 Thiobacillus thiooxidans Wakaman and Joffe. (Jour. Bact., 7, 1922, 239, Sulfomonas thiooxidans Wakaman, Jour. Bact., 7, 1922, 616; Thiobacterium thiooxydans Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 617) From Greek theion, sulfur and M. L. to oxidize.

Short rods: 0 5 by 10 micron with rounded ends. Occur singly, in pairs, or in chains. Motile by means of a single polar flagellum. Gram-negative (Starkey, Soil Sci., 39, 1935, 210).

Thiosulfate agar: Scant growth. Nearly transparent colomes.

Sulfur medium (liquid): Uniform turbidity. No sediment or surface growth. Medium becomes very acid (below pH 10).

Thiosulfate medium (liquid): Uniform turbidity. Medium becomes acid and sulfur is precipitated. Nitrogen sources, Utilizes ammonia

nitrogen but not nitrate nitrogen which is toxic. Asparagin, urea and peptone not utilized.

Temperature relations. Optimum 28° to 30°C. Slow growth at 18° and 37°C. Death occurs at 55° to 60°C.

Optimum reaction: pH 20-3.5. (Limiting reactions, pH 6.0 to less than pH 0.5.)

Strictly autotrophic, deriving its energy from the oxidation of elementary sulfur and thiosulfate, oxidizing these to sulfuric acid. It utilizes the CO<sub>2</sub> of the atmosphere as a source of carbon.

Strictly aerobic.

Distinctive characters: This species produces more acid, from ovidation of sulfur, and continues to live in a more acid medium, than any other living organism yet reported, the hydrogen-ion concentration of the medium increasing to a pH 0 8 and less.

Source: Isolated from composts of soil, sulfur, and rock phosphate and soils containing incompletely oxidized sulfur compounds.

Habitat: Soil.

3. Thiobacillus novellus Starkey. (Jour. Bact., 28, 1934, 365; Jour. Gen. Physiol., 18, 1935, 325; Soil Sci., 59, 1935, 207, 210.) From Latin novellus, new.

Short rods or ellipsoidal cells: 0.4 to 0.8 by 0.6 to 1.8 microns. Non-motile.

Gram-negative.

Gelatin stab. Mucoid growth at point of inoculation Sub-surface growth meager. Slow liquefaction

Agar plate: Growth slow, colorless, moist, raised, circular, 1 mm in diameter. Deep colonies tiny, lens-shaped.

Thiosulfate agar plate: Growth slow, becoming white from preespitated sulfur. Surface colonies small, esrcular, moist. Crystals of CaSO<sub>4</sub> appear throughout the

Agar slant Growth fairly abundant, soft, somewhat ropy, raised, shining, moderately spreading; whitish in reflected light, brownish opalescence in transmitted light.

Thiosulfate agar slant: Growth very thin, practically colorless. No sub-surface growth Sulfur usually precipitated as white frosty film on the surface.

Agar stab. White to cream-colored growth confined close to point of inoculation. Penetrates to bottom of tube.

Thiosulfate agar stab. No appreciable surface growth

Broth Slightly turbid. Gelatinous pellicle Forms long streamer-like network extending surface to the

bottom Some sediment.

Thiosulfate solution medium: Uniform turbidity. No pellicle Whitish sediment with thin incomplete membrane on the bottom of the flask Reaction acid in a few days, changes pH 7 8 to 5 8 with decomposition of a small quantity of throsulfate.

Sulfur solution medium of slightly alkaline reaction No growth

Potato slant Growth limited, creamcolored, moist, shining, slightly brown Litmus milk. Slow development of

slight alkalimity.

Facultative autotrophic.

Optimum reaction: Close to neutrality (limiting reactions pH 5.0 to 90).

Aerobic

Distinctive characters: Oxidizes thiosulfate to sulfate and sulfuric acid. Does not oxidize free sulfur.

Source: Isolated from soils.

Habitat: Soils.

4. Thiobacillus coproliticus Lipman and McLees. (Soil Sci., 50, 1940, 432.) Latinized form of the English word coprolite, fossil dung.

Long thin rods: 01 to 02 by 6 to 8 (may measure 3 to 40) microns. Straight, S-shaped, and curved cells. Mottle by means of a single polar flagellum

Peptone soil extract agar: Slight

Nutrient solution. Little or no growth. Thiosulfate agar: Slow development. Produces small watery colonies raised above the agar surface. Colonies have been noted which were white from precinitated suffer.

Thiosulfate solution: Thiosulfate is oxidized. Lattle or no turbidity. No pellicle. No sediment. Change in reaction from pH 76 to 61.

Sulfur medium: Sulfur is oxidized. No turbidity.

Facultative autotrophic.

Aerobic.

Distinctive characters: Develops in inorganic media and oxidizes thiosulfate and sulfur to sulfate, Media with slightly alkaline reactions most favorable for growth.

Source: Coprolite rock material from Triassic period (Arizona)

Habitat · Unknown

5. Thiobacillus denitrificans Beijernek. (Cent. f. Bakt., II Abt., 11, 1004, 507; Sulfomonas denitrificans Orha-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 314.) From Latin, de, from; and M.L. nitrifico, to nitrify

Short rods, 0.5 by 1 to 3.0 microns long Motile by means of a single polar flagellum (Tjulpanovn-Mossevitch, Arch. d. Sei. Biol., U.S.S.R., 80, 1930, 203). Inorganic liquid medium Growth with

production of gas, predominantly nitrogen.

Thiosulfate agar medium: Colonies

Thiosulfate agar medium: Colonies thin, clear, or weakly opalescent.

Optimum reaction: Neutral or slightly alkaline.

Autotrophie, utilizing carbon from CO, carbonates and bicarbonates Considered to be strictly autotrophic by Lieske (Ber. d. deutsch. botan. Gesell., 50, 1912, 12.) and facultative by Tuplanova-Mossevitch (Ior. cit.). Beyerinck stated (Kon. Akad. v. Wetenschappen Amsterdam, 42, 1920, 599) that whereas the organism developed initially in an inorganic medium, it lost the autotrophic habit by cultivation in an organic medium.

Facultative anaerobic or even microacrophilic. Can live in the absence of free O<sub>2</sub> in the presence of nitrate.

Distinctive characters Oxidizes thronulfate to sulfate under marcrobic conditions using nitrate as the hydrogen acceptor which is reduced to N<sub>2</sub>. Also oxidizes sulfide, elemental sulfur, and dittionate:

Habitat: Canal and river water, salt water, soil, peat, composts and mud.

Appendix: The following species have been placed in *Thiobacillus* or are regarded as belonging to the genus:

Thiobacillus concreticorus Parker. (Austral. Jour. Exper. Biol. and Med. Sci., 25, 1915, 81) From corroded concrete sowers. Similar to or identical with Thiobacillus thiooxidans Waksman and Jose.

Thiobacillus crenatus Emoto. (Froc. Imp. Acad. Tokyo, 5, 1929, 149.) Isalated from mud of hot springs in Japan See description, Manual, 5th ed., 1939, 84. Almost identical with Thiobacillus thiooxidans Waksman and Joffe.

Thiobecullus lobatus Emoto (loc. cit, p 148). Source and relationships as above. See description, Manual, 5th ed., 1939. 83.

Thiobacillus thermitanus Emoto (Bot. Msg. Tokyo, 42, 1928, 422.) Source and relationships as above. See description, Manual, 5th ed., 1939, 83.

Thiobacillus trautweinii Bergey et al. See Flavobacterium appendix.

Thiobacillus umbonatus Emoto (loc. cit., p. 150). Source and relationships as above. See description, Manual, 5th ed., 1939, 84.

Thiobacterium beijerinckii Issatchenko and Salimowskaja (Zur Morphologie u. Physiol. der Thionsäurekkterion (Rusvian with German abstract). Izviestia Gasud. Gidrobiol. Inst., No 21, 1928, 61.) From salt seas in Russia. Similar to or identical with Thiobactillus thioppurus Beijerinck.

Thiobacterium benjerinchis var. jacobcenti Issatschenko and Salimonskaja (loc. cit). Variety of previously mentioned species.

Thobacterium nathansons Issatchenko and Salimonskaja (loc cit.). From salt scas in Russia. Similar to or identical with Thiobacillus thioparus Beijerinek.

## FAMILY II. PSEUDOMONADACEAE WINSLOW ET AL.

(Jour. Bact., 2, 1917, 555.)

Cells without endospores, clongate rods, straight or more or less spirally curved. One genus (Mycoplana) has branched cells. Usually motile by polar flagella which are either single or in small or large tufts. A few species are non-motile. Gram-negative (a few doubtful Gram-positive tests are recorded in Pseudomonas). Grow well and fairly rapidly on the surface of ordinary culture media excepting Methanomonas and some vibrios that attack cellulose. They are preferably aerobic, only certain vibries including Desulfontbrio being anaerobic. Either water or soil forms, or plant or animal pathorens.

Key to the tribes of family Pseudomonadaceae.

1. Straight rods.

Tribe I. Pscudomonadeae, p. 82.

2. Cells more or less spirally curved.

Tribe II. Spirillege, p. 192.

TRIBE I. PSEUDOMONADEAE KLUYVER AND VAN NIEL.

(Cent. f. Bakt., II Abt., 94, 1936, 397.)

This tribe includes all of the straight and branching rods of the family.

Key to the genera of tribe Pseudomonadeae.

I. Soil and water bacteria. Few animal and many plant pathogens. Usually produce a water-soluble bigment which diffuses through the medium as a

bluish-green or yellowish-green pigment.

Genus I. Pseudomonas, p. 82.

 Cells usually monotrichous with yellow non-water-soluble pigment. Mostly plant pathogens causing necrosis.

Genus II. Xanthomonas, p. 150.

III. Soil bacteria which oxidize methane.

Genus III. Methanomonas, p. 179.

IV. Bacteria which oxidize alcohol to acctic acid.

Genus IV. Acetobacter, p. 179.

V. Soil and water bacteria known to attack protamines.

Genus V. Protaminobacter, p. 189.

VI. Soil bacteria with branching cells. Capable of using aromatic compounds, as phenol, etc., as a source of energy.

Genus VI. Mycoplana, p. 191.

# Genus I. Pseudomonas Migula.\*

(Migula Arb. bakt. Inst. Karlsruhe, 1, 1894, 237; Bacterium Ehrenberg emend. Cohn, Beitr z Biol d Pflanzen, 1, Heft 1, 1872, 167; Bactrillum Fischer, Jahrb f. wissensch Bot, 27, 1895, 139, Bactrinium Fischer, ibid., 439, Arthrobactrinium Fischer, ibid., 139; Arthrobactrillum Fischer, ibid., 139; Bactrilius Kendall, Public Health, 28, 1902, 484; Bactrillus Kendall, ibid; Bacterium Ehrenberg emend. Smith, Bacteria

<sup>\*</sup>Revised for the 5th ed. of the Manual by Prof. D. H. Bergey, Philadelphia, Penniania, 1937. Further revision for the 6th ed by Prof. R. S. Breed, New York State Experiment Station, Geneva, New York, with incorporation of the plant pathogenic species by Prof. Walter H. Burkholder, Cornell University, Ithaca, New York. April. 1943.

in Relation to Plant Disease, 1, 1905, 171; Denitromonas Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 314; Liquidomonas Orla-Jensen, 1bid., 332; Lamprella Enderlein, Sitzber. Gesell. naturf. Freunde, Berlin, 1917, 317; Fluoromonas Orla-Jensen, Jour Bact., 6, 1921, 271)

Cells monotrichous, lophotrichous or non-motile II pigments are produced, they are of greenish hue, fluorescent, and water-soluble." Gram-negative except Nos. 88, 122 and 128. Frequently ferment glucose, sometimes with the formation of visible gas. Inactive in the fermentation of lactose. Nitrates are frequently reduced either to nitrites or ammonia, or to free nitrogen. Some species split fat and attack hydrocarbons. Soil, water, and plant pathogens; very few animal pathogens. Certain salt water species (Nos 59-64) some of which live in heavy brine are temporarily retained in this genus although they produce non-water-soluble pigments or phosphorescence. From Gr pseudes, false, monas, a unit; M. L. monad.

The type species is Pseudomonas aeruginosa (Schroeter) Migula.

#### Key to the species of genus Pseudomonas.

- Soil and fresh water forms with a few that are pathogenic on cold or warm blooded animals.
  - 1. Green fluorescent pigment produced.
  - Gelatin liquefied.
    - b. Polar flagellate.
      - e. Grow readily at 37°C. Usually bluish-green.
        - 1 Pseudomonas aeruginosa. 2 Pseudomonas iaegeri
      - cc. Grow poorly or not at all at 37°C.
        - d. Milk not coagulated becoming alkaline
          - e, Soil and water organisms. Not known to
            - digest\_cellulose.
              - 3 Pseudomonas fluorescens. 4 Pseudomonas viscosa
              - 5. Pseudomonas fairmountensis.
              - Pseudomonas urcae.
                 Pseudomonas pavonacea.
            - ee. Soil forms that attack cellulose.
            - ee. Soil forms that attack cellulos 8 Pseudomonas effusa.
            - eee Pathogenic for lizards.
            - 9. Pseudomonas reptiluorous,
        - dd. Milk unchanged becoming blue in association with lactic acid bacteria.
          - Pseudomonas syncyanea.
        - ddd. Milk coagulated.
        - Pseudomonas schuylkilliensis
           Pseudomonas chlororaphis.
          - 13 Pseudomonas myzogenes.
          - 13 Pseudomonas myzogenes 14. Pseudomonas sepisca
        - dddd. Soil form. Action on milk not recorded
          15. Pseudomonas borcopolis.

<sup>\*</sup>Sec Tobie, Jour. Boet., 49, 1945, 459 for a discussion of the nature of these pigments.

I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 86.)

Etymology: Greek megalos, large; sporos, seed, spore; large spored.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: About 80 to 160 microns wide, rounded, cushion-shaped, dark flesh color. Spores 2 microns

Source and habitat: Jahn (loc. cit.), on stag dung near Berlin.

Illustrations: Jahn (loc. cit.) Fig. Y, i to k, p. 87.

 Chondrococcus macrosporus Krzemieniewski. (Acta Soc. Bot. Poloniac, 4, 1926). According to Krzemieniewski, not to be confused with Zukal's species, Myzococcus macrosporus (Ber. d deutsch Bot. Gesellsch., 15, 1897, 542.)

Etymology: Greek makros, long, large; sporos, seed, spore; large-spored.

Swarm stage (pseudoplasmodnum): Not described

Fruiting bodies: Much like Chondrococcus coralloides, differing in color and in size of spores. Spores 16 to 2.0 microns. Fruiting body yellow or light brown color, with long branches.

Source and habitat. Krzemieniewski (loc. cit.), found it first on leaves, later isolated from soil on rabbit dung.

Illustrations: Krzemieniewski (loc. cit.) Pl II, Fig. 19.

5 Chondrococcus blasticus Beebe. (Iona State Col. Jour. Sci., 15, 1941, 310.) Etymology · Greek blastikos, budding.

Fruiting body. Primary: Spherical to subspherical, usually sessile but occasionally with a short stalk or foot; pale pink to bright salmon pink; 300 to 600 microns in diameter. No outer wall or limiting membrane evident. Develops on sterilized rabbit dung in from 3 to 6 days at room temperature. Secondary Arising as bud-like growth from the primary fruiting body. Develops into irregularly shaped, finger., corai- or bud-like protuberance. Seldom branched; occasionally stalked but usually sessile on

primary fruiting body until latter is utilized in formation of several secondary fruiting bodies. Deep pink to salmon pink in color. Variable in size and shape; 50 to 150 by 75 to 225 microns. No outer wall or limiting membrane evident.

Spores: Spherical, thick-walled, highly refractile; 1.2 to 1.4 microns in diameter Held together in the fruiting body by the mass of slime.

Vegetative cells: Long, slender, flevible rods, straight or curved to bent, ends rounded to slightly tapered, Gramnegative. 0.5 to 0.6 by 3 0 to 5 0 microns. Usually found in groups of 2 to 12 lying parallel on the surface of the slimy colony, the group moving as a unit. Motile by a crawling or creeping motion, to flagella.

Vegetative colony: Thin, colorless, transparent at margin; surface broken by many small ridges or veins. Center smooth, slightly thicker, often showing pale pink color. Fruiting bodies first form at or near center, later distributed irregularly on other parts of colony. Margin composed of active vegetative

cells.
Physiology: Good growth on mineral sait agar to which has been added such complex carrbohydrates as dulcitol, inulin cellulose, reprecipitated cellulose rot destroyed apprecially. an utilize agor as both Cand N sources. Best growthon suspensions of killed b terial cells in agar Growth inhibited partially or entirely by arabimose, mannose and

maltuse.
Source: Goat dung and soil, Ames,

Iowa.

Habitat: Soil. Decomposes organic
matter, especially bacterial cells in
dune.

Illustrations: Beebe (loc. cit.) Pl. 11, Figs. 5-6, pl. IV, Fig. 18.

6 Chondrococcus cerebriformis (Kofler) Jahn. (Myzococcus cerebriformis Kofler, Sitzber. d. kais. Akad. Wiss., Wien. Math.-Nat. Riasse, 122

- Cysts 60 to 170 microns, without definite envelope, in swollen brain-like arrangement
- 6 Chandrococcus cerebriformis.
  2. Cysts 30 to 35 microns, numerous, and embedded in a thick slime envelope
  11 Chandrococcus coralloides var.
  polycystus.

#### II. Parasitic on fish.

1 Chondrococcus coralloides (Thaxter) Jahn (Myzooccus coralloides)
Thaxter, Bot. Gar., 17, 1892, 401; Myzooccus digitatus Quebhl, Cent f Bakt.,
II Abt., 16, 1906, 18 (pro parte); Myzooccus claratus Quebh, ibid; Myzococcus claratus Quebh, ibid; Myzococcus polycytus Kofler, Sitzberg, d. kais Wiss, Wien Mat.-Nat Klasse, 122 Abt., 1013, 865 (pro parte); Myzococcus exiguus Kofler, ibid, 867 (pro parte); Chondrocccus polycytus Kremienienski, Act Son Bot Poloniae, 4, 1929, 46)

Etymology Greek korallion, coral, eidos, like

Swarm stage (pseudoplasmodium) Rod masses pale pinkish, thin, rods slender, curved 4 to 7 by 0.4 microns Readily cultivated on lichens and on potato agar

Fruiting bodies: Very variable in shape, usually with rounded coral-like pincesses, recumbent or upright, sometimes with finger like outgroaths or rounded constrictions, usually small, about 50 micross in diameter, protuberances 20 to 30 microns wide, light rove to flesh color. Spores 1 to 1.2 microns. Jahn concludes that the species segregated by Quebl and by Kofler are of varietal rank only Krzeniicniewski (1925) regards Chondroceus polygutus (Kofler) Krzeniicniewski as a distinct species.

Source and habitat: Thatter (1822), uncommon an America, on lichers Very common in Europe, Jahn (1921), relatively common on Ondorset rabbit, hare, bares, deer, old brik and old lichers Gost durg from Lapland and Italy. Rofer (1913), dungof feld mice, bares, hares, gusts, two and deer. Kreenlenies-ski (1927), common in Pulsh soil.

# 7 Chondrococcus columnaris

Illustrations Thanter (1892, loc. cit.) Pl 24, Figs. 29-33, Quebl (1996, loc. cit.) Pl 1, Figs. 1 and 9. Koffer (1913, loc cit) Pl 1, Figs. 4, Pl 2, Fig. 9. Kracmeniewski (1995, loc cit) Pl 11, Figs. 15-18. Jahn (1921, loc. cit.) Fig. Y, p. 87.

- In. Chondrococcus corralloides var. claratus varies from Chondrococcus coralloides in having fruiting bodies simple or branched rather than constricted or jointed.
- 1b. Chondrococcus corrolloides varpolicystus varies from Chondrococcus corolloides, in having its fruiting bodies simple swellings or "cyst heaps" rather than branched, and in bring recumbent rather than erect
- Chondrococcus cirrhosus (Thatter) Jahn. (Nyzococcus cirrhosus Thatter, Bot Gaz, 25, 1807, 409, Jahn, Beiträge zur botanischen Protistologie I. Die Polyangiden, Geb Borntracker, Leipzig, 1921, 200)

Etymology Modern Latin from Greek cirrhos, tanny

Swarm stage (pseudoplasmodium); Rods 0.8 by 2 to 5 microns

Fruiting bodies Elongate, upright, thickened below, alender above, extended to a rounded point, 50 to 100 microna lorg, 20 microna in diameter at base, light red to fiesh-colored. Spores about 1 micron.

to flesh-colored - Spores about 1 micms.
Source and habitat: Tharter (loc. cil.),
once only on grouse dung, Mass.

Illustrations Tharter (for cit ) II. 31, Figs 25-27

3 Chondrococcus megalosporus Jahn. (Heiträge zur botanischen Protistologie. Etymology: Greek diskos, a quoit, discus; Latin formis, shape.

Swarm stage (pseudoplasmodium): Rods 0.5 to 0.6 by 2 to 3 microns.

Fruiting bodies: Cysts disk-shaped, crowied, sessile, attached by a more or less ragged scar-like insertion, or in masses. Cysts yellowish when young, when old dark orange-yellow, about 35 by 10 microns. Cyst wall distinct, thin, becoming very slightly wrinkled. Spores irregularly epherical, embedded in visure of the property of the control of the c

(1927, loc. cit.), rare in Polish soils.

Illustrations Thaxter (loc. cit.) Pl. 27, Figs. 19-21. Krzemieniewski Acta Soc. Bot. Poloniae, 4, 1926, Pl. II, Figs. 21-22

 Angiococcus cellulosum Mishustin. (Microbiology, Moscow, 7, 1938, 427.)

Etymology: Modern Latin cellulosum, cellulose.

Fruiting body: Regularly rounded (less frequently extended or angular), 20 to 150 microns in diameter; yellow or pink in color, to drabbish when old. Encysted cells surrounded by a colorless cyst wall

or envelope. Usually 1 to 3 short stalks or cystophores up to 10 microns high. Within outer wall are numerous cysts containing resting cells (spores). Cysts have regularly rounded form; unpigmented to yellow; 5 to 15 microns in diameter, average 6 microns. Number of cysts in fruiting body increases with age.

Spores: Cocci (term used is shortened rods) combined into globular aggregations easily broken up. Size not given.

Vegetative cells: 0.4 to 0.5 by 15 to 2.0 microns. Cell contents pigmented gray, and of indefinite outline (?).

Vegetative colony: Fairly rapid growth on cellulose with silica gel. Colony has a yellowish cast. Reaches diameter of 15 to 2.0 cm after 6 days with center yellowish-pink and margin tinged light pink. Surface moist. Fruiting bodies more numerous at center, but distributed over entire area. Fruiting bodies do not noticeably protrude above the surface of the colony.

Physiology: Cellulose attacked but not completely destroyed. Lower fibers remain intact, but on treatment with hot soda solution they fall spart

Habitat : Soils.

Genus IV. Sporocytophaga Stanier.

(Jour. Bact., 40, 1940, 629.)

Diagnosis: Spherical or ellipsoidal microcysts formed loosely in masses of slime among the vegetative cells. Fruiting bodies absent.

Etymology: Greek sporos seed, spore; kytos hollow place, cell and phagein to est. The type species is Sporocytophaga myzococcoides (Krzemieniewska) Stanier.

Key to the species of genus Sporocytophaga.

- Microcysts spherical.
  - A. Does not utilize starch.
    - 1 Sporocytophaga myzococcoides.
  - B. Utilizes starch.
- 2. Sporocytophaga congregata.
- II. Microcysts ellipsoidal.
- 3. Sporocytophaga ellipsospora.

Abt., 1913, 866; Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntracger, Leipzig, 1921, 86.)

Etymology. Latin cerebrum, brain; forms, shape.

Swarm stage (pseudoplasmodium): Rods 4 to 12 microps.

Fruiting bodies: About 1 mm long, clumped masses with swollen upper surface, brain-like, violet rose, often lead-gray Cysts 100 to 170 microns, without slime envelope Spores 1.1 to 16 microns Jahn (loc. cit.) suggests that this may be Archangium gephyra

Source and habitat : Kofler (loc cit ),on

Illustrations: Kofler (loc. cit ) Pl 2, Figs 7 and 8.

 Chondrococcus columnaris (Davis) Ordaland Rucker. (Bacillus columnaris Davis, Bull. U. S. Bur. Fisherres, 53, 1923, 291, Ordal and Rucker, Proc. Soc. Exper. Biol and Med., 56, 1914, 18, also see Fish and Rucker, Trans. Amer. Fish Soc., 73, 1914 in press; (2) Phylogog columnaris Garnjobst, Jour. Bact., 49, 1915, 113)

Ptymology. From Latin columnaris, rising in the form of a pillar.

ising in the form of a pillar. Vegetative cells: Flexible, weakly refractive, Gram-negative rods, 0.5 to 0.7 by 4 to 8 microns. Creeping motion observed on solid media, and flexing movements in hquids.

Spores (microcysts). 0.7 to 1.2 microns, spherical to ellipsoidal, occurring on both liquid and solid media.

Physiology Growth best on 0.5 to 050 per cent agar with 0.25 to 050 per cent Bactotryptone at pl17.3. Colonics on tryptone agar yellow, flat and irregular. Edge uneven with swarming apprent Gelatin luquefied rapidly. No indole. No reduction on futrates. Starch, cellulose and agar not attacked. Sugars not fermented, but elucose oxidized.

Fruiting bodies on agar not deliquescent, and surrounded by a firm membrane. A peculiar type of fruiting body formed in liquid media. Where organsums are in contact with infected tissues or with scales, produce columnar, sometimes branched, fruiting bodies in which typical spores (microcysts) develop in 7 to 10 days.

Source and habitat: I'rst described as cause of bacterial disease of warm water fishes (Davis, loc. cit) and later in fingerlings of the cold water blue black rulmon (Oncorrhynchus nerko). Transmissible to sulmonid fishes.

#### Genus III. Anglococcus Jahn.

(Beitrige zur Protistologie I Die Polyangiden, Geb Borntraeger, Leipzig, 1921, 80.) A segregate from Myzococcus Thavter Dagnosis Frutting body consisting of nurrerous round (disk shaped) cysts, cyst

nall thin, spores within.

Etymology Greek anguon, seemel and kokkos, coreum (ball)

Etymology Greek angion, sessel and tokkes, coreus (ball)
The type species is Angiococcus disciformis (Thatler) Jahn

Key to the species of genus Angiococcus.

1 Cysts yellow to dark orange yellow, disk shaped, 35 microns in diameter

1 Angiococcus discilormis

B Cysts colorless to yellow, round, up to 15 microns in districter.

2 Angiococcus cellul sum,

1 Anglococcus disciformis (Thaxter) Jahn (Myzococcus disciformis Thaxter, 1ht., Gas., 37, 1991, 412, Jahn, Beiträge

rur betanschen Protistologie I. Die Polysraden, Geb Berntreezer, Leipzig, 1921, 89 ) (Cent. f. Bakt., I Abt., Orig., 96, 1925, 426.) From sea water.

Spirochaeta minima Dobell. (Dobell, Arch. f. Protistenk., £6, 1912, 117; not Spirochaeta mnima Pattit, Contribution a l'Étude des Spirochétidés, Vanves, 11, 1928, 187 (Treponema minimum Beauropaire-Aragão and Vianna, Mem. Inst. Oswaldo Cruz, 5, 1913, 211.).) One of the smallest khown Spirochaeta, 0.5 by 2 0 to 2.5 microns. From water of the river Granta at Cambridge. Similar to Spirochaeta fulgurans.

Spirochaeta vivax (Dobell) Zuelzer. (Treponema vivax Dobell, Arch. f. Protistenk., 26, 1912, 117, Zuelzer, 1925, in Prowazek, Handb. d. path. Protoz., 3.

1931, 1669.) From fresh water of the river Granta at Cambridge

Spirochaete kochii Trevisan. (Spirochaete des Wollsteiner See, Koch, in Colm, Beitr. z. Biol. d. Pflanzen, z. Hett 3, 1877, 420; Trevisan, Batter. Ital., 1879, 26; Spirillum kochii Trevisan, I generi e le specie delle Batteriacce, 1889, 24.) From water.

Spirochaete schroeteri Cohn. (Jahresber. d. Schles. Gesellch. f. 1883, 108; quoted from Schroeter, in Cohn, Kryptog. Flora v. Schlesien, § 1, 1889, 1885, Spirillum schroeteri Cohn, quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, §, 1889, 1007.) Similar to Spirochaete cohnii. From cellar walls.

# Genus II. Saprospira Gross.

(Mittheil Zool Stat. zu Neapel, 20, 1911, 190.)

Spiral protoplasm without evident axial filament. Spirals rather shallow. Transverse markings or septs (?) seen in unstained and stained specimens. Perplast membrane distinct. Motility active and rotating, Free-living in marine ozze.

The type species is Saprospira grandis Gross.

1 Saprospira grandis Gross. (Mitteil. Zool. Station zu Neapel, 20, 1911,

190 ) From Latin, great.

Cylindrical, 1 2 by 80 microns in

length, with obtuse ends
Spiral amplitude is 24 microns.

Waves large, inconstant, shallow, irregular, 3 to 5 in number, sometimes almost straight.

oot straight.
Anial filament absent.
Cross-striations present.
Membrane distinct
Division transverse
Flexible, clastic
Crista absent.

Source Found in intestinal tract of the

Habitat. Free-living in foraminiferous sand.

2. Saprospira puncta Dimitroff.

(Jour. Bact., 12, 1926, 146.) From Latin, pitted.

Large spirals: 1.0 by 86 microns with

pointed ends.

The spiral amplitude is 4 to 8 microns.

The average number of tuass is 3.

Avial filament absent.

Cross-striations present.

Membrane distinct.

Division transverse. Source · Found in oysters.

Source · Found in oysters

3 Saprospira lepta Dimitroff. (Jour. Bact., 12, 1926, 144.) From Latin, small. Large spirals: 0.5 by 70 0 microns, with pointed ends.

The spiral amplitude ranges from 5 to 13 microns.

3 microns.

The spiral width varies from 1 6 to 4.8

microns.

The average number of turns is 6.

Axial filament absent.

Cross-striations present.

 Sporceytophaga myxococcoldes (Krzemieniewska Stanier. (Spirochaeda cytophaga Hutchinson and Clayton, Jour. Agr. Scn., 9, 1919, 150; Cytophaga myxococoudes Krzemienienska, Arch Mikrobiol., 4, 1933, 400; Cytophaga globulosa Stapp and Bortels, Cent f Bakt., II Abt., 90, 1934, 47, Cytophaga hutchinsonii Imeeneeki and Solntzeva, Bull. Acad Sci. U.S.S.R., Ser. Biol, No 6, 1936, 1129; not Cytophaga hutchinsoni Winogradsky, Ann. Inst. Pasteur, 45, 1929, 578; Stanier, Jour Bact., 40, 1910, 630

Etymology . Modern Latin from generic name Myzococcus, and eidos, like

Vegetative morphology: Flexible, singly occurring rods, 03 to 04 migron wide at the center, tapering to both ends. Length 3 to 8 microns according to Krzemieniewska (loc cit), 25 to 5 microns according to Jensen (Proc. Linn Soc. N. So. Wales, 65, 1940, 547) May be straight, bent, U-shaped or S-shaped Show erceping motility (Stapp and Bortels, loc cit ) Stain poorly with ordinary aniline dyes; with Giemsa's stain, the young cells are colored uniformly except for the tips. As the rods shorten and swell to form microcysts, the chromatin becomes concentrated and moves toward the center of the cell. generally in the form of two parallel bands (Krzemieniewska, Acta Soc. Bot. Pol., 7, 1930, 514).

Microsysta Spherical, 13 to 16 micross in distincter, covered with a cheath of mucus. According to Krzemieniensky (1920, loc cit), germination is by emergence of the shortened red from the sheath, followed by elongation; according to Stapp and Bortles (for cit) and Imienceki and Solutieva (for cit), by a simple elongation of the entire microsyst

Growth is strictly confined to cellulose On mineral salts-silica gel plates covered with filter paper, yellow, glistening, slightly mucilaginous patches are produced after a few days. The color gradually assumes a light brownish tinge on aging. The filter paper in these regions is eventually completely dissolved and the patches become translucent.

Ammonia, nitrate, asparagin, aspartic acid and peptone can serve as sources of nitrogen (Jensen, loc. cit.).

Strictly aerobic.

Optimum temperature 28 to 30°C.

Source: Isolated from soil.

Habitat: Soil, Decomposes cellulose.

2 Sporocytophaga congregata Fuller and Norman. (Jour. Bact., 45, 1943, 567.)

Etymology: Latin congrego, to as-

Vegetative cells are long, flevuous rods with pointed ends, 0.5 to 0.7 by 5.5 to 8.0 microns. Creeping motility on solid surfaces.

Spores (microcysts): Spherical, 0.7 to 1.1 microns in diameter. Usually occur in localized regions within the colony.

Growth on starch agar is smoky, later turning yellow Colonies are irregularly round, slightly concave Edge is smooth

cells gather into groups and in these regions a large number of spherical spores are found.

Growth on cellulose devtrin ager is pule; colonies are small and concree. Hollowing of the ager is limited to the area of colony growth

Glucose, galactose, lactose, maltore, sucrose, arabinose, calcium gluconate, starch, cellulose dextrin, pectin, and hemicellulose are utilized. Filter paper is not attacked

Ammonium, nitrate, and peptone are suitable nitrogen sources

Indo'e not formed.

Nitrates not produced from nitrates

kaiserl. Gesundheitsamte, 30, 1909, 379; Bergey et al., Manual, 1st ed., 1923, 423.) From Latin, of a mussel.

Spirals: 0 5 to 3.0 by 10 to 60 microns, round in section with blunt ends, the one being slightly more pointed than the other.

They have a ridge or comb running along one side but no terminal filaments. Cross-striations distinct.

The chromatin granules are grouped in fours.

An undulating membrane can be demonstrated.

Source: Pound in the intestinal canal of the scallop (Pecten jacobacus).

Habitat: From the crystalline style of molluses.

Appendix: Additional species which appear to belong in this genus are:

Cristispira acuminata (Schellack)
Ford. (Spirochaeta acuminata Schellack, Arb. kais. Gesundheitsante, 30,
1909, 379, not. Spirochaeta acuminata
Castellani, Brit. Med. Jour, 2, 1905,
1330; Ford, Texth of Bact., 1927, 1932.)
From the crystalline style of a molluse,
Tapes lacka.

Cristspira cardii-papillosi (Schellack) Ford. (Spirochaeta cardii-papillosi Schellack, Arb kais. Gesundheitssinte, 50, 1909, 379, Ford, Textb. of Baet, 1927, 939.) From the crystalline style of a molluse. Cardium papillosum

Cristispira chamae (Schellack) Noguchi (Sprochacta chamae Schellack, Arb kass. Gesundheitsamte, 30, 1909, 370; Noguchi, Jour. Exp. Med, 27, 1918, 583.) From the crystalline styles of molluses, Chama spp.

Cristispira gostrochaenae (Schellack) Ford (Spirochaeta gostrochaenae Schellack, Arb. kais. Gesundheitsamte, 30, 1909, 379; Ford, Textb. of Bact., 1927, 940.) From a shellfish, Gastrochaena dubia. Constant length 29 microns

Cristispira helgolandica Collier. (Cent f. Bakt., I Abt. Orig., 86, 1921, 132.) Found three times in the body fluid of an echinoderm, Asterias rubens, in the North sea. Average length 63 microns. Named for the place where the investigation was made (Helgoland).

Cristispira interrogationis Gross. (Mittheil. Zool. Station zu Neapel, 20, 1910, 41.) From the intestinal canal of the

scallop, Pecten jacobacus.

Cristispira Limae (Schellack) Ford. (Spirochaeta Imme Schellack, Arb kais. Gesundheitsamte, 39, 1909, 379; Ford, Textb. of Bact., 1927, 939.) From the crystalline styles of molluses, Lima spp. Similar to Cristispira balbiantii.

Cristispira mactrae (Prowazek) Ford. (Spirochacta mactrae Prowazek, Arch. I. Schilfs- u. Tropenhyg., 14, 1910, 27; Ford, Teath. of Bact., 1927, 940.) From the digestive tract of a shellfish, Mactra sulcatoria.

Cristispira mina Dimitroff. (Jour. Bact, 12, 1926, 159.) Found in cysters.

Cristispira modiolae (Schellack) Noguchi. (Spirochaeta modiolae Schellack, Arb. kais. Gesundheitsamte, 50, 1909, 379; Neguchi, Jour. Evp. Med., 27, 1918, 583.) Found in mussels and oysters.

Cristispira ostreae (Schellack) Noguchi. (Spirochacta ostreae Schellack, Arb kais. Gesundheitsamte, 50, 1909, 373; Noguchi, Jour. Exp. Med., 27, 1918, 583) From the crystalline style of the oyster, Ostrea edulis. Identical with Cristispira anodonice Gross.

Cristispira pachelabrae de Mello. (Compt. rend. Soc. Biol., Paris, 84, 1921, 241.) From the digestive tract of a shelffish, Pachelabra moestra.

Cristispira pareula Dobell. (Arch. f. Protistenk., 28, 1912, 117.) From the crystalline style of a malluse, Venus (Meretriz) castra, in Ceylon. The smallest Cristispira known—0.4 to 0 5 by 20 to 15 microns.

Cristispira pectinis Gross. (Mitthell. Zool Sta. zu Neapel, 20, 1910, 41.) From the digestive tract of a scallop, Pecken jacobseus. Identical with Cristispira balbianis Gross.

Cristispira polydorae Mesnil and Caul-

Membrane distinct.

Division transverse.

Source: Found in oysters in Baltimore, Maryland.

Appendix: The following species have been placed in this genus. Saprospira flexuosa Dobell. (Arch. f. Protistenk, 26, 1912, 117.) Isolated once from water of the river Granta at Cambridge.

Saprospira nana Gross. (Mittheil. Zool. Sta. zu Neapel, 20, 1911, 188.) From foraminiferous sand.

#### Genus III. Cristispira Gross.

#### (Mittheil. Zool. Stat. zu Neapel, 20, 1910, 41.)

Flexuous cell bodies in coarse spirals, 23 to 120 microns in length. Characterized by a crista or thin membrane of varying prominence on one side of the body extending the entire length of the organism. Cross-striations. Actively motile. Found in the intestinal tract of molluses.

The type species is Cristispira balbianii (Certes) Gross.

 Cristispira babbianii (Certes) Gross. (Trypanosoma babbianii Certes, Bull. Soc. Zool. de France, 7, 1882, 347; Spurochaeta babbanii Swellengrebel, Ann. Inst Past., 24, 1907, 362; Spirochaeta babbanii Borrel and Cernovodeanu, Compt. rend Soc. Biol., Paris, 62, 1907, 1102; Gross, Cent. I Bakt, 1 Abt., Orig, 63, 1912, 90)

Cylindrical: 10 to 30 by 10 to 120 nucrons, with obtuse ends

Spiral amplitude is 8 microns. Spiral depth is 16 microns. Waves 2 to 5, sometimes more, large, irregular, shallow.

Axial filament absent

Cross striations present

Membrane distinct Flexible, clastic.

iron bemotoxylin.

Crista present, a ridge-like membrane making one to two complete turns

Terminal spiral filament absent Highly motile end portion absent

Stains, Cell membrane behaves like chitin or cutin substance. Stains violet by Giemes's solution, and light gray by

Trypsin digestion: Membrane resistant, crists and strictions disappear.

Bile salt (10 per cent), Crista quickly dissolves

Saponin (10 per cent). Crista lecomes fibrillar, il en indistinct.

Source. From the crystalline style of oysters.

Habitat: Parasitic in alimentary tract of shell-fish.

2 Cristispira anodontae (Keysselitz) Gross (Spirochaeta anodontae Keysselitz, Arb. a Laiserl. Gevundheitsamte, 23,1905,566; Gross, Cent f. Bakt., I Abt., Orig., 65, 1912, 000) From M.L., mussels

0.8 to 1.2 by 41 to 88 mirrons with sharply pointed ends, flattened and possessing an undulating membrane. The periphast is fibrilly in apperance and there is a dark granule at each end of the undulating membrane. The chromatin material is distributed in the form of globules or elongated lands.

Large spirals. The average width of the spiral is 2 microns. The average wave length is 8 microns.

The number of complete turns ranges from 5 to 11

Habitat. Found in the crystalline style of fresh water muscle, incidenta copied and it mutabilis, also in intestinal tract of orsters.

3 Cristispira pinnse (Gonder) Bergey et al. (Spiricharle pineae Gonder, Cent. f. Bakt., I. Aht., Orig., 47, 1205, 421; Spirechie's pinnae Schellack, Art., a. d.

## FAMILY II, TREPONEMATACEAE SCHAUDINN.

(Deutsche med. Wochnschr., \$1, 1905, 1728.)

Coarse or slender spirals, 4 to 16 microns in length; longer forms due to incomplete or delayed division. Protoplasm with no obvious structural features. Some may show terminal filaments. Spirals regular of irregular, flexible or comparatively rigid. Some visible only with dark field illumination. Parasitic on vertebrates with few exceptions. Some pathogenic. Many can be cultivated.

Key to the genera of family Treponemataceae.

I. Stains easily with ordinary aniline dyes.

Genus I. Borrelia, p. 1058.

II. Stain with difficulty except with Giemsa's stain and silver impregnation.

A. Strict anaerobes.

Genus II. Treponema, p. 1071.

B. Aerobes.

Genus III. Leptospira, p. 1076,

### Genus I. Borrella\* Swellengrebel.

(Swellengrobel, Ann. Inst. Past., 21, 1907, 582; Spiroschaudinnia Sambon, in Manson, Tropical Diseases, August, 1907, 833, Cacospira Enderlein, Sitzber. Ges. Natust. Freunde, Berlin, 1917, 390; Entomospira Enderlein, 1914, Spironema Bergey et al., Manual, 1st ed., 1923, 424; not Spironema Vuillemin, Compt. rend. Acad. Sci. Paris, 140, 1905, 1567; Spirochaeta Gieszczykiewicz, Bull. Acad. Polonaise d. Sci. et Lettres, Cl. Sci. Math. et Nat. Sef B. 1939, 24.)

Length 8 to 16 microns Coarse, shallow, irregular, with a few obtuse angled spirals. Generally taper terminally into fine filaments. Stain easily with ordinary amiliar dyes. Refractive index approximately the same as that of true bacteria. Parasitic upon many forms of animal life. Some are pathogenic for man, other mammals and birds. Generally hematophytes are found on mucous membranes. Some are transmitted by the bites of arthropods.

The type species is Borrelia anserina (Sakharoff) Bergey et al.

1. Borrella anserina (Sakharoff) Bergey et al. (Spirochaeta anserina Sakharoff, Ann. Inst Past, 5, 1891, 564; Spirillum anserum (sic) Sternberg, Man. of Bact , 1893, 499; Spirillum anserinum Macé, Traité Pratique de Bact , 4th ed., 1901, 1060, Spirochaete anserina Mace, ibid.; Spiroschaudinnia anserina Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 403; Spironema anserina Nozuchi, Jour. Exp. Med., 27, 1918, 584; Bergey et al., Manual, 2nd ed , 1925, 435, Treponema anserina Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun., 1928, 456.) From Latin, pertaining to geese

Synonyms: Spirochaeta marchouxi Nuttall, Epidemiol. Soc., London, 24, 1904, 12 (Spirille de la poule, Marchoux and Salimbeni, Ann. Inst. Past., 17, 1903, 569, Spirochaela gallinarum Stephens and Christopher, Practical Study of Malaria and Other Blood Parasites, Liverpool, 1905; Borrelia gallınarum Swellengrebel, Ann. Inst. Past., 21, 1907, 623; Spirochaete gallinarum Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 623; Spironema gallinarum Gross, Cent. l. Bakt., I Abt., Orig., 65, 1912, 92; Spiroschaudinnia marchouzi Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 403; Spironema marchouzi Ford,

<sup>\*</sup>Further revision of the genus by Prof. E. G. D. Murray, McGill Univ., Montreal, P. Q. Canada, April, 1947. Reviewed by Dr. Gordon E. Davis, Rocky Mountain Laboratory, U.S.P.H.S, Hamilton, Montana.

lery. (Compt. rend. Soc. Biol, Paris, 79, 1916, 1118; Cristispirella polydorae Hollande, Compt. rend Acad Sci Paris, 172, 1921, 1696). From a marine annelid, Polydora flata.

Cristispira pusilla (Schellack) Ford. (Spirochaeta pusilla Schellack, Arb kais Gesundheitsmate, 59, 1900, 379; Ford, Textb of Bact, 1927, 910) From the digestive tract of a mussel, Anodonta mutchilis.

Cristispira sazicavae (Schellack) Ford (Spirochaeta sazicavae Schellack, Arb hais Gesundheitsamte, 50, 1909, 379, Ford, Textb. of Bact., 1927, 940) From the crystalline style of a molluse, Sazicava artica

Cristispra spiculifera (Schellack) Dimitroff. (Spirochaeta spiculifera Schellack, Arb. kais Gesundheitsamte, 30, 1909, 379, Dimitroff, Jour Bact, 12, 1926, 157.) Found in mussels

Cristispira tapetos (Schellack) Gross (Spirochaeta tapetos Schellack, Arb kais. Gesundheitsamte, 50, 1909, 379; Gross, Cent. f. Bakt, I Abt., Orig., 65, 1912, 84.) From the crystalline style of a mollusc, Tapes decussata.

Cristispira (enua Dimitroff. (Jour. Bact., 18, 1925, 160.) Found in oysters. Cristispur eneris Dobell. (Quart. Jour Microse Sci. London, 54, 1910-1911, 507 and 19td, 66, 1911, Part 3) From a clam, Venus (Meretriz) castre, in Ceylon Identical with Cristispura balbanti Gross.

Cristspirella cartae Hollande. (Compt rend Acad. Sci. Paris, 172, 1921, 1633) From the intestune of a guinea pig. Probably a protocoan. Evidently the sama as Heliconema (see appendix to Borretia) Both Cristispirila Polydorae and Cristspirila caruae have characteristics at variance with accepted ideas of spirochaetes.

Spirochaela solenis Fantham. (Ann. Trop. Med and Parasitol., 5, 1911, 479.) A parasite of a molluse, Solen ensis.

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MANUAL OF DETERMINATIVE BACTERIOLOGY
          bb. Non-motile.
                c. Grows readily at 37°C.
                                  16. Pseudomonas smaragdina.
               cc. Grows poorly or not at all at 37°C.
                                 17. Pseudomonas chlorina.
    aa. Gelatin not liquefied.
          b. Polar flagellate.
               c. Grow readily at 37°C. Usually bluish-green.
                                 18. Pseudomonas oleovorans.
                                 19. Pseudomonas incognita.
                                 20. Pseudomonas convexa.
                                 21. Pseudomonas mildenbergis.
              cc. Grow poorly or not at all at 37°C-
                     d. Milk not coagulated.
                                 22. Pseudom nas putida.
                                 23. Pseudo fionas scissa.
                                24. Psev domonas ovalis.
                                 25. P. Leudomonas striata.
                    dd. Milk coar Pseudomonas denitrificans.
                                 27. Pseudomonas solaniolens.
        bb. Non-motile.
              c. Grows poorly,
                     d Mill for or not at all at 37° C.
                            not congulated.
                                  28. Pseudomonas eisenbergii.
2. Green fluorescent pigmer
                          Lit not produced or not reported.
    a. Gelatin liquefied.
         b. Polar flagellatifg
              c. Grow pd
                    suga figurity or not at all at 37°C. No visible gas from
                    d. I
                          Rapid reduction litmus. Putrid odor.
                                  29. Pseudomonas puirefaciens.
                         Slow reduction litmus. Alkaline.
                                  30. Pseudomonas mephitica.
                                  31. Pseudomonas geniculata.
                       sc Acid congulated.
                                  32. Pseudomonas fragi.
             cc. Acid a
                         nd visible gas from glucose. Optimum tempera-
                  ture
                        I. variable.
                    d.
                        arLitmus milk reduced and alkaline.
                                  33. Pseudomonas nebulosa.
                  dd. Hen, itmus milk acid coagulated.
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chi

34. Pseudomonas coadunata

35. Pseudomonas multistriata. 36. Pseudomonas punctata. 37. Pseudomonas hydrophila. 38. Pseudomonas ichthyosmia. Texth. of Bact., 1927, 955; Spirochacla gallinae Ford, idem; Treponema gallinarum Noguchi, in Jordan and Falk, Nener Knowledge Bact. and Immun, 1928, 461; Treponema marchouri Gay et al. Agents of Disease and Host Resistance, 1935, 1977). The cause of septicaemia in chuckens.

Spirochaeta granulosa penetrans Balfour, Jour. Trop. Med and Hyg. 70, 1007, 153 (Spirosehaudimna granulosa Ballour, Jour. Trop Veter., Calcutta, 5, 1910, 303; Spironema granulosa Ford, Textb of Bact, 1927, 957) From spirochetosis of fowls in Sudan.

Spirochacta nicoller Brumpt, Bull Soc Path. Evot, 2, 1909, 285 and/or Précis de Parasitol, Paris, 1st ed., 1910 (Galli-Valerio, Cent. f. Bakt., f. Abt., Ong., 50, 1909, 189 and 61, 1912, 292; Spironema nicoller Ford, Tevth of Bact., 1927, 988; Treponema nicoller Gry et al., Agents of disease and Host Resistance, 1935, 1977) From spirochetosis of geese in Tunisia

Spirochaeta neeuzi Brumpt, Bull Soc Path. Evot., §, 1909, 285 (Spirocakaudinnia neeuzii Castellani and Chalmers, Man Trop. Med., 2nd ed., 1013, 401; Spironema neeuzii Ford, Textb of Bact, 1927, 938, Treponema neeuzii Gay et al., Agents of Diesase and Host Resistance, 1933, 1077). The cause of foul spirochetosis in Senega

Spirochaeta gallinarum var hereditaria Neumann and Mayer, in Lehmann, Med Atlanten, 11, 1914, 276 A North African strain of fowl spirochetosis

Borrelia pullorum Redowitz, Amer Jour Med. Technol, 2, 1936, 91 Γrom diseased chickens

Spirochaeta analis Parrot, Bull Soc Path. Exot, 13, 1920, 647. Pathogenic for domestic ducks in Algeria.

Morphology, 0.25 to 0.3 by 8 to 20 microns, averaging about 1 spiral per micron.

Actively motile, with lashing movements

Stains readily with amiline dyes and Giemsa's stain

Cultivation: Can be cultivated in Noguchi's ascitic fluid-rabbit kidney medium

Immunology: Antigenically distinct from species found in mammals.

Arthropod vectors: Transmitted by the bites of ticks (Argas persicus, A. miniatus, A. reflexus and Ornithodoros moubata)

Pathogenic for birds but not for mammals.

Source From blood of infected geese, ducks, fowls and vector ticks.

Habitat The cause of spirochetosis of fowls

2 Borrelia recurrentis (Lebert) Bercev (Obermeier, Berlin klin, Wochet al schr., 1873, 152; Protomucetum recurrentis Lebert, Ziemssen's Handbuch, 2, 1874, 267: Spirochacte obermeteri Cohn. Bestr. z Biol d Pflanzen, I, Heft 3, 1875, 196; Spirillum obermeiers Zopf, Die Spaltpilze, 3 Aufl , 1885, 71; Spirochaeta obermeters Migula, in Engler and Prantl, Die naturl. Pflanzenfam , 1, 1a, 1895, 35; Spirochaete recurrentis Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 621; Spirochaeta recurrentis Castellani and Chalmers, Man. Trop Med., 1st ed., 1910, 305; Spironema recurrentis Gross, Cent. f. Bakt , I Abt , Orig , 65, 1912, 85; Spiroschaudinnia recurrentis Castellani and Chalmers, Man Trop Med , 2nd ed., 1913, 398, Spironema obermeieri Park and Williams, Pathogenic Microoreanisms, 6th ed , 1917, 513, Cacospira recurrentis Enderlein, Sitzungsber d Gewlisch, naturf. Freunde, 1917, 313; Treponema recurrentis Brumpt, Nouveau Traité de Medecine, Paris, 4, 1922, 508, Treponema obermeiers Brumpt, thid ; Cacospira obermeiers Enderlein, Bakterien-Cyclogenie. 1925, 251, Bergey et al , Manual, 2nd ed , 1925, 433, Spirillum recurrentia Ford. Textb of Bact , 1927, 918, Spiroschaudinnia obermeieri Ford, ibid.) From Latin, recurring

Cylindrical or slightly flattened, 0.35 to 0.5 by 8 to 16 mierons, with pointed ends.

Spiral amplitude 1.5 microns.

Spirals large, wavy, inconstant, about 5 in number.

Terminal finely spiral filaments present.

Highly motile end portion absent.

Matility: By active cork-screw motion without polarity. Lashing movements common in drawn blood.

Stains with common aniline dyes. Gram-negative. Violet with Giemsa's stain. Bile salts (10 per cent): Disintegration

complete. Saponin (10 per cent): Immobilized in

Saponin (10 per cent): Immobilized in 30 minutes, then broken up in a few hours. In some a skeletal structure remains.

Cultivation: Can be cultured in ascitic or hydrocoel fluid to which a piece of sterile rabbit kidney is added. Optimum reaction pH 7.2 to 7.4.

Immunology: Serum does not agglutinate Borrelia duttons.

Accidental and experimental transmission by conjunctival sac and skin abrasions.

Discase in experimental animals (small rodents after monkey passage) mild.

Arthropod vector. Louse (Pediculus humanus) which evhibits normal transmission from the 16th to the 28th day. Found in the bed-bug (Cimez lectularus) and ticks, but not transmitted by them. No evidence of hereditary transmission in the louse.

Habitat The cause of European relapsing fever. Transmissible to man, monkeys, mice and rats.

3. Berrella duttonii (Nevy and Knapp)
Bergey et al. (Dutton and Todd,
British Med. Jour., 2, 1903, 1259; Sperillum dultoni Novy and Knapp, Jour.
Infect. Dis., 8, March 18, 1963, Spriochaets
J. June 16, 1903, 1609; Spirochaets
duttoni Lehmann and Neumann, Bakt.
Diag., 4 Aufl., 2, 1907, 623; Spironema
duttoni Gross, Cent. f. Bakt, I Ab.
Orig., 65, 1912, 94; Spirochaeta Micro-

spironema duttoni Duboscq and Lebailly, Compt. rend. Acad. Sci., 164, 1912, 662; Spiroschaudinnia duttoni Castelfiani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 299; Treponema duttoni Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 497; Caccapira duttoni Endetlein, Bakterien-Cyclogenie, 1925, 284; Bergey et al., Manual, 2nd ed., 1925, 431.) Named for Dutton, who discovered this orranism.

Morphology: Similar to Borrelia recur-

Cultivation: Growth occurs under anaerobic conditions in scrum water, hydrocoel or ascitic fluid to which a piece of sterile rabbit kidney is added.

Immunology: This organism is antigenically distinct from other causes of relapsing fever.

Pathogenic for mice and rats. Disease in small redents and many other experimental animals very severe

Arthropod vector: This species is transmitted to man through the bite of the tick (Ornithodoros moubata) by feat contamination of the bite. In the tick the organism goes through some granulation or fragmentation phenomenon, the nature of which is not understood Hereditary transmission to at least the third generation of the tick. Not transmitted by the louse.

Habitat: The cause o' Central and South African relapsing 10 er.

4. Borrella kochil (Novy) Bergey et al. (Spirochaela lochi Novy, Pree Path. Soc. Philadel., N S. 10, 1907, 1; Spirochaela rossi Nuttall, Jour. Roy. Inst. Pub. Health. London, 16, 1903, 385; Spiroschaudinnia rossii Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 400; Spiromema kochi Noguchi, Jour. Exp. Med., 27, 1918, 581; Trepomena kochi Brumpt, Nouveau Traité de Médocine, Paris, 4, 1922, 497; Trepomena rossi Brumpt, ibid.; Bergey et al., Manual, 2nd ed., 1925, 437; Bergerla rossi Statut, 2nd ed., 1925, 437; Bergela rossi Statut, 2nd ed., 1926, 432, 2nd ed., 1926, 432)

Named for Koch, who first observed spirochetes in East African relapsing fever.

Morphology . Similar to that of Borrelia recurrentis.

Cultivation Same as for Borrelia recurrents.

Immunology: Antigenically distinct from both Borrelia recurrentis and B. duttonii.

Pathogenic for mice and rats Arthropod vector No record.

Habitat: The cause of African relapsing fever.

5. Borrelia novyl (Schellack) Bergey (Spirochaete from relapsing fever, Norris. Pappenheimer and Flournov. Jour Inf. Dis . 3, 1906, 266, Spirochaela novus Schellack, Arb. kaiserl. Gesundheitsamte, 27, 1907, 199 and 364, Spirenema novy: Gross, Archiv f. Protistenk , 24, 1912, 115; Spiroschaudinnia notyi Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 400; Treponema norm Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 508, Cacospira novyi Enderlein, Bakterien-Cyclogenie, 1925, 251; Bergey et al., Manual, 2nd ed , 1925, 431) Named for Novy, the American hacterialogist

Morphology Similar to that of Borrelia recurrentis.

Cultivation Same as for Borrelia re-

Immunology. Antigenically distinct from other relapsing fever organisms

Pathogenic for monkeys, white rats and white mice.

Arthropod vector. Unknown Habitat Recovered from a patient in

Habitat Recovered from a patient in Bellevue Hospital, New York Origin of infection unknown

6 Borrella berbera (Sergent and Foley) Bergey et al (Spirochaeta berbera Sergent and Foley, Ann Inst Part, 24, 1910, 337, Spirochaudinnia berbera Castellani and Challmers, Man. Trop Med., 2nd ed., 1913, 402; Spironema berbera

Noguehi, Jour. Exp. Med., 27, 1918, 581, Spirochaeta berbers Kolle and Hetsch, Exper. Bakt. u Infekt., 6 Aufi., 1, 1922, 811; Treponema berberum Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 96, Bergey et al., Manual, 2nd ed., 1925, 435.) Named for the Berbers, a tribe of Northern Africa.

Morphology: More tenuous than other relapsing fever organisms, 02 to 03 by 12 to 21 microns.

Cultivation: No record of its cultiva-

tion.
Immunology: Antigenically distinct

from Borrelia recurrentis.

Arthropod vector: Possibly carried by

the louse (Pediculus restiments).
Source: Found in cases of relapsing

fever in Algiers, Tunis and Tripoli.

Habitat: Cause of relapsing fever in

Habitat: Cause of relapsing fever in North Africa. Is virulent for monkeys. Produces non-fatal infections in rats and mice

7. Borrelia carteri (Mackie) Berrev et al. (Spirochaeta earters Mackie, Ann. Trop Med and Parasitol., 1, 1907, 157 and Indian Med. Gazette, 44, 1908, 370; Spirillum carteri Mackie, Lancet, 2, 1907. 832, according to Ford, Textb. of Bact., 1927, 950; Spiroschaudinnia earleri Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 401; Spironema carteri Noguchi, Jour Exp Med , 27, 1918, 581; Treponema carters Brumpt, Nouvenu Traité de Médecine, Paris, 4, 1922, 497, Bergey et al , Manual, 2nd ed , 1925. 435 ) Named for Carter, who in 1879 described this organism in the blood of patients with Indian relapsing fever.

Morphology: Similar to Borrelia berbera.

Cultivation Not recorded.

Immunology: Probably a distinct speces A succession of distinct serological type-occurs with the relapses in a single infection (Cunningham et al., Par Lastern Association of Tropical Medicine, Tol yo, 1925; Indian Journal of Medical Research, 22, 1934-1935, 105 and 595; 16id., 24, 1937, 571 and 581).

Arthropod vector: Carried by either Pediculus vestiments or Cimex rotundatus or by both.

Habitat: The cause of Indian relapsing fever. Transmissible to monkeys, rabbits, rats and mice

8. Borrelia theileri (Laveran) Bergey et al. (Spirochaeta theileri Laveran. Compt. rend. Acad. Sci., Paris, 136, 1903, 939; Spiroschaudinnia theileri Castellani and Chalmers, Man. Trop Med., 2nd ed., 1913, 404, Spironema theileri Noguchi, Jour. Evp Med., 27, 1918, 584; Bergey et al., Manual, 2nd ed., 1925, 435; Spirillum theilers and Spirochaete theilers Pettit, Contribution à l'Étude des Spirachétidés, Vanves, II, 1928; Treponema theileri Noguchi, in Jordan and Falk, Newer Knowledge Bact, and Immun., 1928, 461) Named for Theiler, who discovered this organism in 1902 in Transvaal, South Africa

Morphology . 0 25 to 0.3 micron by 20 to 30 microns with pointed ends.

Cultivation. No record

Immunology. Is distinct from the species infecting man.

Arthropod vector. Transmitted by the tick (Rhipicephalus decoloratus)

Source · Blood of cattle.

Habitat Blood of cattle and other mammals in South Africa

9. Borrella glossinae (Novy and Knapp) Bergey et al (Spirillum glossinae Novy and Knapp, Jour. Inf. Dis., 3, 1906, 385; Spirochaeta glossinae Castellani and Chalmers, Man Trop. Med., 1st ed., 1910, 310, Spiroschaudinnia glossinae Castellani and Chalmers, ibid., 3rd ed., 1919, 454; Spironema glossinae Bergey et al., Manual, 1st ed., 1923, 425; Bergey et al., Manual, 2nd ed., 1925, 435, Entomospira glossinae Enderlein, Bakterien-Cyclogenie, 1925, 254; Treponema glossinae Ford, Textb of Bact., 1927,

988.) Named for the genus of insects, Glossina.

Morphology: 0.2 by 80 microns, occurring singly, sometimes in pairs. Generally 4 spirals. Shorter, narrower and has more turns than has Borrelia recurrentis

Habitat: Found in the stomach contents of the tse-tse fly (Glossina palpalis).

10. Borrelia buccale (Steinberg) Brumpt. (Spirochaeta buccalıs Steinberg, 1862, according to Hoffmann and Prowazek, Cent. f. Bakt., I Abt., Orig., 41, 1906, 819; Spirochaete cohnii Winter, Die Pilze, 1879, 61; (?) Microspira buccalis Lewis, The Lancet, 1884, quoted from Schroeter, in Cohn, Kryptog Flora v. Schlesien, S, 1, 1889, 169; Spirochaete buccalis, quoted from Schroeter, ibid, 168; Spirillum cohnii Trevisan, I generí e le specie delle Batteriacee, 1889, 24; Spirillum buccale Macé, Traité Pratique de Baet , 4th ed., 1901, 1962; Spirochaeta inaequalis Gerber, Cent. f. Bakt, I Abt., Orig., 56, 1910, 508; Spirochaeta undulata Gerber, idem; Treponema buccale Dobell, Arch. f. Protistenk, 26, 1912, 117. Spironema buccale Gross, Cent. i. Bakt , I Abt., Orig., 65, 1912, 84; Spiroschaudinnia buccalis Castellani and Chalmers, Man. Trop. Med , 3rd ed., 1919, 450; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 495; Treponema inaequale Brumpt, ibid.; Treponema undulatum Brumpt, sbid., 514.) From Latin buccalis, buccal.

Morphology 0 4 to 0 9 by 7 to 20 microns. The largest of the mouth spirochetes.

Motility: Active, serpentine, rotating

and flevuous. Staining: Stains with aniline dyes and

is violet with Giemsa's stain Cultivation: Has not been obtained in pure culture and probably does not grow in any medium tried to date.

Habitat: In normal mouths and invades formed lesions of the respiratory nuccus membrane.

11. Borrelia vincentii (Blanchard) Bergey et al. (Spirochaeta vincenti Blanchard, Arch. f. Protistenk . 10, 1906, 129; Spirochaeta schaudinni Prowazek, Arb. kaiserl, Gesundheitsamte, 22, 1907, 23; Spirochaete plaut-rincenti Lehmann and Neumann, Bakt. Diag , 5 Aufl , 2, 1912, 579. Spiroschaudinnia vincenti Castellani and Chalmers, Man. Trop. Med., 2nd ed , 1913, 402, Spiroschaudinnia schaudinni Castellani and Chalmers, idem. Spironema uncenti Park and Williams, Pathogenic Microorganisms, 6th ed , 1917, 506; Treponema vincenti Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514: Trenonema schaudinni Brumpt, idem; Bergey et al., Manual, 2nd ed . 1925, 435.) Named for Vincent, the French bacteriologist.

Morphology. 0.3 by 8 to 12 microns, 3 to 8 reregular shallow spirals. Stains easily with the common aniline dyes and is Gram-negative

Motility Has a rapid progressive and vibratory motion

Cultivation Can be cultivated under anaerobic conditions. Cultures may show long forms with only a writhing motion.

Not pathogenic for laboratory animals. Habitat. Found on normal respiratory mucous membrane and is associated with a fusiform bacillus (l'usobacterium plauti-vincenti) in Vincent's angina

12 Borrella refringens (Schaudinn and Hoffmann) Bergey et al (Spirochaela refringens Schaudinn and Hoffmann, Arbeiten kaiserl. Gesundheitsamte, 22, 1905, 528; Spirochaela refringens Hoffmann and Prowatek, Cent f Itakt., I Abt., Orig. 44, 1906, 712; Spirochaudinnia refringens Gross, Arch f Protistenk. 24, 1912, 1915, Spirochaudinnia refringens Gastellini and Chalmers, Man. Trop Med., 3rd ed., 1919, 439; Trepomar afringens Castellani and Chalmers, tidd., 461; Bergey et al., Manud., 2nd ed., 1923, 430; Frop Lattin, refractive.

Morphology: 0.5 to 0.75 by 6 to 20 microns. Spirals are coarse and shallow. Spirals are generally smoothly rounded and regular, tapering towards the end into a fine projection Stains easily by common dyes In stained specimens the spirals appear irregular

Motility. Active serpentine and rotating motion with marked flexion

Cultivation. Uncertain Pathogenicity: None.

Source Found with Treponema pallidum in some cases of syphilis as originally described by Schaudinn

Habitat. Genital mucous membranes and necrotic lesions of the genitalia of man.

13. Borrella hyos (King and Drake) Bergey et al. (Hog cholera virus, King and Baeslack, Jour Inf Dis., 12, 1913, 39; Spirochaela suis King, Baeslack and Hoffmann, Jour. Inf. Dis., 12, 1913, 235; not Spirochaela suis Bosanquet, Spirochetes, Saunders, 1911, Spirochaela hyos King and Drake, Jour. Inf. Dis., 16, 1915, 51, Spironema hyos Bergey et al., Manual, 1st ed., 1923, 426, Bergey et al., Manual, 2nd ed., 1925, 436; Spironema suis Ford, Texth. of Bact., 1927, 939) From Greck, hog

Morphology .1 micron by 5 to 7 microns Distinctly shorter and thicker than other members of the genus

Motility Active spinning motion, spirals fixed.

Cultivation Grows under anaerobic conditions in the presence of tissue.

Habitat. Found in the blood, intestinal ulcers and other lesions of hogs suffering from hog cholera

14 Borrelia hermsi (Davis) Steinhaus. (Spirochaeta kermsi Davis, Amer. Assoc. Adv. Sci., Pub No 18, 1912, 16; Steinhaus, Insect Microbiology, 1916, 453)

Investigations by Davis (loc cit) indicate that each species of Ornithodoros that is a relapsing fever vector earries a spirochete that is tick-host specific and that this host specific relationship offers a more accurate approach to the differentiation of relapsing fever spirochetes than any of the several criteria previously used.

This was shown to be the case for Borrelia herms; and Borrelia parker; For this reason no attempt is made to describe the morphology and other characters of the relapsing fever spirochetes of North and South America.

Borrelia hermsi is transmitted by Ornithodoros hermsi.

A cause of relapsing fever in the Western part of the U.S.A.

15. Borrelia parkeri (Davis) Steinhaus. (Spirochaeta parkeri Davis, loc. cit.; Steinhaus, loc. cit.)

Transmitted by Ornithnodoros parkeri.
A cause of relapsing fever in the Western part of the U.S.A.

16. Borrella turicatae (Brumpt) Steinhaus (Spirochaela turicatae Brumpt, Comp. rend. Soc. Biol, Paris, 115, 1933, 1369; Steinhaus, loc. cut.)

Transmitted by Ornsthodoros turicala.

A cause of relapsing fever in Mexico,
Texas and nearby areas.

17. Borrella venezuelensis Brumpt (Treponema renezuelensis Brumpt, Nouveau Traité de Médecine, Paris, 4, 1921, 492; Brumpt, thd., 495; Spirochaela tenezuelensis Pettit, Contributions à l'Étude des Spirochétidés, Vanves, £,1928, 295)

Transmitted by Ornsthodoros rudis (O. renezuelensis).

A cause of South American relapsing fever.

Brumpt (Précis de Parasitologie, 3rd ed., Paris, 1936) regards thus species as identical with Borrelia neotropicalis (Bates, Dunn and St John) Steinhaus. (Treponema neotropicalis Bates, Dunn and St John, Amer. Jour. Trop. Med , 1, 1921, 183, Spirochaeta neotropicalis St John and Bates, Amer. Jour. Trop. Med , 2, 1922, 251; Steinhaus, loc ett.). Transmitted by Ornithodoros venezuelensis A cause of relapsing fever in Panamas.

Appendix: Many of the species included in this appendix are so inadequately described that it is not certain that they belong in this group.

Borrelta phagedenis (Noguchi) Bergey et al. (Spirochasta phagedenis Noguchi) Jour. Exp. Med., 16, 1912, 261; Spirochaudinnia phagedenis Castellani and Chalmers, Man. Trop. Med., 2nd ed, 1913, 403; Treponema phagedenis Brumpt, Nouveau Traité de Médecino, Paris, 4, 1922, 511; Spironema phagedenis Bergey et al., Manual, 1st ed., 1923, 425; Bergey et al., Manual, 2nd ed., 1925, 435.) From phagedenous ulcer.

Heliconema pyrphoron Scholer. (Cent. f. Bakt., I Abt., Orig., 138, 1937, 342.) From human blood. Pathogenic.

Heliconema vincenti Sanarelli. (Ana. Inst. Past., 44, 1927, 701.) From the intestine of a guinen pig. Shows stages between spirochetes and fusiform bacilli (See Hindle, Med. Res. Council Syst. of Bact., 3, 1931, 130.)

Microspironema merlangi Duboscq and Lebailly. (Compt. rend. Acad. Sci. Paris, 154, 1912, 662) From the whiting, Merlangus merlangus. May be a synonym of Spirochaeta gadi.

Spirillum Sondii Nicolle. (Nicolle, Compt. rend. Soc Bool., Paris, 63, 1907, 213; Spruchaeta gondi Zuelzer, 1925, in Prowazek, Handb d. path. Protox., 5, 1931, 1680.) Found in the blood of a rodent, Ctenodactylus gor. 7. Not pathogenic. Associated with a piroplasma Probably not a spiroche\*

Sprillum latapiei Laveran. (Laveran, Buill. Soc. Path. Evot., 1, 1903, 148; Spirochaeta latapiei Zuelzer, 1925, in Prowazek, Handb. d. path. Protez, 5, 1931, 1633; Spironema latapie; (sic) Ford, Tevtb. of Bact., 1927, 964.) From the blood of a shark.

Spirillum pitheci Thiroux and Dufougeré. (Thiroux and Dufourgeré. Compt. end. Acad. Sci. Paris, 199, 1910, 132; Spirochaeta pitheci Zuelter, 1925, in Prowarck, Handb. d. path. Protoz., 5, 1931, 1676; Spironema pitheci Ford, Textb. of Bact., 1927, 961.) From the blood of an African monkey, Cercopithecus patas Pathogenic for monkeys, rats and field mice. Closely related to Borrela dutlemi

Spirochacta aberiginalis Cleland (Cleland, Jour. Trop Med., 12, 1909, 113, Spirosrhaudinnia aboriginalis Castellann and Chalmers, Man. Trop. Med., 2nd ed., 1913, 402, Treponema aboriginalis Brumpt, Nouveuu Tmité de Médeeue, Paris, 4, 1922, 493). Found in cases of granuloma inguinale in West Australia Probably sanophytic

Spirochaela acuminala Castellani (Castellani piri. Med Jour. \$, 1905, 1333, Spirochaela lenuis acuminala Castellani, idem and/or Arch I Schulfs- u Tropenbyg, 72, 1903, 311; Spirochaedinia acuminala Castellani and Chalmers, Man Trop Med, 3rd ed, 1919, 449, Treponema acuminalam Brumpt, Nou venu Traité de Médecine, Paris, 4, 1922, 495 ) From ulcerated lesions of yaws Spirochaela acutal Kritchenski and

Séguin (Rev. de Stomatol , 22, 1920, 613) From the oral cavity. Spirochaeta aeglefini Henry (Jour Path and Buct , 18, 1913, 222) From

haddock
Spirochaeta aegyptica Gonder (Gonder, in Prowazek, Handb, d path Protoz 6, 1914, 671; Spirochaena aegyptica
Noguehi, Jour Exp. Med, 27, 1918, 581,
Treponema egypticum Brumpt, Noutveut
Tratté de Médecine, Paris, 4, 1922, 500,
Borretta aegypticum Steinhaus, Insect
Microbiology, 1916, 482.) Oliserted in
cases of relapsing fever in Sudan Prob
ahly a spinosym of Borreta recurrentie

Spirocharla ambigum Séguin and Vinrent (Séguin and Vinrent, Compt rend See Biol., Paris, 121, 1906, 498, Treponema ambigua Prévot, Man Class et Determ. d Bsetéries Anaérolies, Paris, 1910, 298.) From the oral existy and the lungs Pathogeme Strictanse rube

Spirochaeta amphibiae Yakimoll and Miller. (Bull See Path. Exot , 18, 1925, 306 ) From the intestines of frogs, Rana temporaria.

Spirochaeta argentinensis Kuhn and (Kuhn and Steiner, Med Steiner. Klin . 13, 1917, 1007; Spirochaeta polusclerotica Arzt and Kerl, according to Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, 134; Treponema (?) argentinensis Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun , 1928, 478 ) I'rom the livers of guinea pigs and rabbits inoculated with blood from patients having multiple seletosis Pathogenic for man, monkeys, dogs, rabbits and guinea pigs Named for the Latin name of the town of Strasbourg (Argentoratum)

Spirocheta balantidis Hoffmann and Prowazek, (Iofffmann and Prowazek, Cent. f Bakt, I Abt, Orig., 41, 1906, 741; Spiroschaudinnia balantidis Castellani and Chalmera, Man Trop Med, 2nd ed., 1913, 401, Spironema balantidis Park and Williams, Pathogenic Microorganisms, 6th ed., 1917, 505; Treponena balantidis Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 490.) From a caso of balantids.

Spirochaeta boriz-caffris Nuttall. (Nuttall, Parasitology, 3, 1910, 108; Spironema boriz-caffris Ford, Textb of Bact, 1927, 960) From the blood of a buffalo.

Spirochaeta bronchialis Castellani (Castellani, Ceylon Medical Reports, 1907; Spirocchaudinnia bronchiolis Castellani and Chalmers, Man Trop Med, 2nd ed, 1913, 402, Treponem bronchiale Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 496). Found in cases of bronchitis in Ceylon. A mixture of several species of mouth spirochaetes is apparently described-under this designation.

Spirochaela bucco phoryngei Macfie. (Macfie, Ann Trop Med and Parasitol., 10, 1916, 329, Treponena bucco-phoryngei Brumpt, Nouveau Trutté de Méderine, Paras, 4, 1922, 477 | From the throat of a rative of the Gold Coast. May be identical with Spirochaela denlium or Sbuccofit.

Spirochaeta bufonis Debell. (Dobell, Quart. Jour. Microsc. Sci., \$2, 1905, 121; Spiroschaudinnia bufonis Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, \$45; Spironema bufonis Ford, Textb. of Bact., 1927, 986; Treponema bufonis Ford, bid.) From the intestines of a toad, Bufo vulgaris.

Spirochasta enesirae retortiformis Hellmann. (Arch. f. Protistenk., 29, 1913, 22.) From the urinary sac of a tunicate,

Caesira retortiforms.

Spirochaeta caesirae septentrionalis.

Hellmann. (Arch. f. Protistenk., 29, 1913, 22.) From the urinary sac of a tunicate, Caesira septentrionalis.

Spirochaeta canna Bosselut. (Bull. Soc. Path. Evot., 18, 1925, 702.) From the blood of a dog.

Spirochaeta canis Macfie. (Ann. Trop. Med. and Parasitol., 10, 1916, 305.) From dog feces.

Spirochaeta cobayae Knowles and Basu, Knowles and Basu, Indian Jour. Med. Res., 22, 1935, 449; Treponema cobayae Topley and Wilson, Princip. Bact. and Immun., 2nd ed., 1936, 725; Borrelia cobayae Steinhaus, Inseet Microbiology, 1946, 454.) From the blood of guinea pigs. Blood parasite belonging to the relapsing fever group. Pathogenic for guinea pigs, rabbits and white rats.

Spirochaeta comandons Séguin and Vinzent. (Séguin and Vinzent, Compt. rend. Soc. Biol., Paris, 131, 1936, 403; Treponema comandons Prévot, Man. Class. et Determ. d Bactéries Anaérobics, Paris, 1940, 208) From the oral cavity. Rather common Non-pathogenic. Stret anaerobe.

Spirochaela crocidurae Leger (Leger, Bull. Soc. Path. Exot., 10, 1917, 289; Treponema crocidurae McFarland, Pathogenic Bacteria and Protozoa, 2nd ed., 1933, 136) From a shrew-mouse, Crocidura stampfiti, in Senegal Transmitted by Ornthodoros erraticus

Spirochaela clenocephali Patton. (Patton, Ann Trop. Med. and Parasitol., 6, 1912, 357; Treponema clenocephali Ford, Textb of Bact, 1927, 989) Parasitic in the digestive tract of the larvae of the Indian cat-fice, Cienocephalus felis.

Spirochaeta cubensis Hoffman. (Sanidad y Beneficienca Boletin oficial, Havana, 28, 1923, 76.) From the feces of Hyla septentrionalis.

Spirochaela culicie Jaffé. (Jaffé, Arch. I. Protistenk., 9, 1907, 1909; Spironma culicis Gross, Cent. f. Bakt., I Abt., Orig., 65, 1912, 87; Enlomospira culicis Enderlein, Sitzungsber. Ges. Naturf. Freunde, Berlin, 1917, 313; Spiroschaudinnia culicis Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 454; Spirillum culicis Pringault, Compt. rend. Soc. Biol., Paris, 84, 1921, 209; Treponema culicie: Ford, Texth. of Bact., 1927, 989.) Found in the intestines and Malpighian tubules of mosquito larvae, Culier sp.

Spirochaeta didelphis Vianna, de Figueiredo and Cruz. (Brasil-Meduco, 26, 1912, 912.) From the blood of an opossum. Didelphis aurita.

Suin, Diacipius airiai.

Spirochaeta equi (Novy and Knapp)
Castellani and Chalmers. (Spirillum
equi Novy and Knapp, Jour. Inf. Dis',
3, 9106, 291; Castellani and Chalmers,
Man Trop. Med., 1st ed., 1910, 909;
Spiroschaudinnia equi Castellani and
Chalmers, Man. Trop. Med., 2nd ed.,
1913, 404; Spironema equi Noguchi, Jour.
Evp. Med., 27, 1918, 581; Treponema equi
Noguchi, in Jordan and Falk, Newer
Knowledge Bact. and Immun., 1928, 461.)
From the blood of a horse. May be
identical with Borrelne theiler.

Spirochaela equina. (Dodd?, Jour. Comp Pathol and Therap., 12, 1906, 318, quoted from Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II, 1923, 111)

Spirochaeta eurygrata Werner (Werner, Cent f. Bakt., I Abt., Orig., 62, 1909, 241; Spironema eurgyratum (sic) Noguehi, Jour. Exp. Med., 27, 1918, 584; Sprroschaudinnia eurgygrata Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 451; Spirillum eurygyrata Castellani lani and Chalmers, tolid.; Borrelia euryaurata Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 495; Treponema euruguratum Brumpt, ibid., 50 ) From the intestinal contents of man.

Spirochaeta exanthematotyphi Futaki (Futaki, Brit Med Jour, Oct 1917; Treponema exanthematotyphi Savini. Compt rend. Soc Biol , Paris, 88, 1923, 958) Found in the kidneys and urine of cases of exanthematous typhus Non-pathogenic.

Spirochaeta febris Chester (Afanassiew, Cent. f. Bakt , I Abt., 25, 1899, 405, Chester, Man Determ, Bact., 1901, 347 ) From a case of recurrent fever

Spirochaeta gadi Neumann (Neumann, Ztschr. f Hyg, 64, 1909, 79; Microspironema gadi Duboscq and Lebailly, Compt. rend Acad Sci Paris, 154, 1912, 662, Treponema gadi Duboscq and Lebailly, Arch. zool expér. et génér, 10, 1912, 331; Spironema gadi Ford, Textb of Bact., 1927, 961 ) From the blood of a sea fish. Gadus minutus

Spirochaeta gallica Couvy and Dujarrie de la Rivière. (Couvy and Duiarrie de la Rivière, Compt rend Soc Biol, Paris, 8t, 1918, 22, Treponema gallicum Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 500 ) From the blood of trench fever patients

Spirochaeta oanoraenac carcinomatosac Hoffmann. (Berl klin Wochnschr , 42, 1905, 880.) From malignant tumors.

Spirochaela gangraenosa nosocomialis Róna (Róna, Verhandl d deutsch dermat Gesellsch , 9, 1907, 471, Treponema gangraenosa nosocomialis Noguchi, Jour Exp Med , 16, 1912, 261 ) From ulcers of the genital region.

Spirochaeta haemophilus Trosier and Sifferien. (Ann Inst Past, 58, 1937, 233 ) From a child with intestinal trou ble and continuous fever

Spirocharta hispanica de Buen (De Buen, Ann Parasitol., 4, 1926, 185; Treponema hispanicum Noguchi, in Jordan and Talk, Newer Knowledge Bact, and Immun , 1928, 481, Spirochaeta marocanum Nicolle and Anderson, Compt. rend Acad Sci Paris, 187, 1928, 747; Amer. Med. Assoc, 49, 1907, 198 8;

Spirochaeta hispanicum var. marocanum Nicolle, Anderson and Colas-Belcour. Arch. Inst Past Tunis, 18, 1929, 343; Treponema hispanicum var marocanum Gay et al . Agents of Disease and Host Resistance, 1935, 1074; Borrelia hispanicum Steinhaus, Insect Microbiology, 1946, 453) The cause of Spanish and Moroccan relansing fever Transmitted by Ornithodoros marocanus Not noglutinated by scrum of Borrelia recurrentis. Pathogenic for man laboratory animals

Spirochaeta intestinalis Macfie and Carter (Macfie and Carter, Ann Trop Med and Parasitol , 11, 1917, 79, Treponema intestinale Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505 ) From human feces.

Spirochacta jonesii Dutton, Todd and (Dutton, Todd and Tobey, Jour Tobey Med Res, 15 (N.S 10), 1906, 491; Spironema jonesis Ford, Textb of Bact. 1927, 964 ) From the blood of an African mudfish, Clarias angolensis

Spirochaeta lagopodis Pantham. (Fantham, Proc Zool, Society, London, 1910. 692. Spironema lagopodis Noguchi, necording to Pettit, loc. cit ) From the blood of the grouse, Lagonus scoticus.

Spirochaeta leucotermitis Hollande. (Arch zool expér et gén , 61, 1922, 23 ) From an insect, Leucotermes lucifugus.

Spirochaeta lorati Tantham, (Proc. Zool Society, London, 1910.) From the intestinal contents of the grouse. Laganus scoticus

Spirochaeta lowenthali Besson son, p. 736, according to Ford, Textb. of Bact, 1927, 1001.) From malignant Lumors

Spirochaeta lutrae Prowazek, (Prowazek, Arb. kaiserl Gesundheitsamte. 26, 1907, 31 , Spiroschaudinnia lutrae Castellani and Chalmers, Man. Trop. Med . 2nd ed , 1913, 401; Spironema lutrae Pord. Textb of Bact., 1927, 961.) From the blood of an otter, Luira sp.

Spirochaeta lymphaticus Proceeher and (Procecher and White, Jour. White.

1925, 306.) From the intestines of frogs, Rana temporaria.

Spirochaeta tenuis Gerber. (Gerber. Cent. f. Bakt., I Abt., Orig., 56, 1910, 508; Treponema tenue Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514.) May be identical with Spirochaeta dentium or with Borrelia vincentii.

Spirochaeta termetis (Leidy) Dobell. (Vibrio termitis Leidy, Jour Acad. Nat. Sci., Phila., 2nd Ser., 8, 1881, 441; Spirachaeta minei Prowazek, Arch. f Schiffsu. Tropenhyg., 14, 1910, 297; Dobell. Spolia ceylanica, 3, 1910, 78; Treponema minei Dobell, ibid ; ? Spirochaete grassii Doffein, Prob. der Protistenk., 2, 1911, 17: Spirochaeta grasmi Döflein, Die Natur der Spirochaten, Jena, 1911; Treponema termitis Dobell, Arch. f. Protistenk., 28, 1912, 117; Entomospira grassii Enderlein, Sitzungsber, Ges. Naturf. Freunde, Berlin, 1917, 313; Cristispira termitis Hollande, Arch. Zool. Expér. et Gén , 61, 1923, N. and R , 25; Treponema grassi Ford, Textb. of Bact., 1927, 988.) From the intestines of Termes lucifugus and Calotermes spn.

Spirochaeta tropidonnii Dobell. (Dobell, Spolia ceylanica, 7, 1911, 65, Spironema tropidonoti Ford, Textb of Bact., 1927, 962.) Isolated once from the blood of a snake, Tropidonotus stolatus, in

Cevlon.

Spirochaeta urethrae Mache. (Mache. Ann. Trop. Med. and Parasitol , 10, 1916, 305; Spiroschaudinnia urethrae Castellani and Chalmers, Man Trop Med , 3rd ed , 1919, 451; Treponema urethrae Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514.) From the urine of Gold Coast natives. Causes acute arthritis

Spirochaeta usbekistanica Pickoul. (Russ. Jour Trop Med , 6, 1928, 612 ) From cases of relapsing fever in Bokhara

Spirochaeta vespertitionis (Novy and Knapp) Castellani and Chalmers rillum respertitionts Novy and Knapp, Jour Inf. Dis , 3, 1906, 291, Castellana and Chalmers, Man Trop Med , 1st ed , 1910, 309; Spiroschaudinnia vespertitionis Castellans and Chalmers, Man Trop.

Med., 3rd ed., 1919, 454; Spironema vespertilionis Ford, Textb. of Bact., 1927, 961.) From the blood of a bat, Vespertılio kuhlii.

Spirochaeta vincenti var. bronchialis Delamare. (Compt. rend. Soc. Biol., Paris, 90, 1924, 611.)

Spirochaeta zlatogorovi Yakimoff. (Bull. Soc. Path. Exot., 14, 1921, 532)

From feces.

Spirochaete exanthematica Lewascheff. (Cent. f. Bakt., I Abt., 18, 1895, 133) From the blood in cases of typhus fever, Spirochaete forans Reiter. (Reiter, Deutsch. med. Wochnschr., No. 50, 1916. 10; see Cent. f. Bakt., I Abt., Orig., 79, 1917, 176; Treponema forans Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922. 500; Spirochaeta forans Pettit, Contribution à l'Étude des Spirochétidés. Vanves, II, 1928, 164.) From the blood in a case of articular rheumatism. Not pathogenic for guinea pigs or mice

Spirochaete gracilis Veszpremi. (Veszpremi, Cent. f. Bakt., I Abt., Orig, 44, 1907, 332; not Spirochaeta gracilis Levaditi and Stanesco, Compt rend. Soc. Biol , Paris, 67, 1909, 185 (Treponema levaditii Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 501; Treponema gracile Brumpt, idem); Treponema gracile Ford, Textb. of Bact., 1927, 978) From a gangrenous phiegmon of the mouth. Found in associ tion with fusiform bacilli and therefor may be identical with Borrelia vincentii or Spirochaela dentsum or Treponema macrodentium.

Spirachaete repacis. (Quoted from Lehmann and Neumann, Bakt. Ding., 6 Aufl., 2, 1920, 809.) From the oral cavity. (Spirochaete Spironema caviae Ford (?), Maesic, Ann. Trop. Med. and Parasitol., 8, 1914, 447; Ford, Textb. of Bact.,

pig at Lagos.

Spironema resperuginis (Gonder) Ford. (Spirochaela resperuginis Gonder, Arb. kais Gesundheitsamte, 27, 1908, 406; Ford, Textb. of Bact., 1927, 981.) Trum the blood of a bat, Vesperugo kuhlii.

1927, 961.) From the blood of a guinea

Spiroschaudinnia eoriae Sangiorgi.

- 39. Pseudomonas ambiaua.
- 40. Pseudomonas sinuosa.
- 41. Pseudomonas cruciviae

cc. Grow poorly or not at all at 37°C.

d. Action on hydrocarbons and cellulose unknown

42. Pseudomonas rugosa dd. Utilize hydrocarbons.

43. Pseudomonas desmolyticum.

44. Pseudomonas rathonis.

45. Pseudomonas dacunhae.

46. Pseudomonas arvilla 47. Pseudomonas salopium,

ddd Utilize cellulose.

48. Pseudomonas minuscula.

49. Pseudomonas tralucida

50 Pseudomonas mira

aaa, Action on gelatin not recorded Produces alcoholic fermentation of glucose

51. Pseudomonas lindners
Sea water to brine species. Some species phosphorescent

a Gelatin liquefied.

b. Polar flagellate

c From sea water. Not deeply pigmented.

d Nitrites not produced from nitrates.

52. Pseudomonas membranoformis. 53. Pseudomonas marinoolulinosa

dd. Nitrites produced from nitrates so far as known

e. Digest agar.

54. Pseudomonas gelatica.

ee Deposit calcium carbonate in sea water gelatin and agar media in old cultures

na ugar media in oid cultures 55. Pseudomonas calcis.

56 Pseudomonas calciprecipitans

eee Causes skin lesions in marine fish.

57 Pseudomonas achthyodermis

cc. Produce highly colored pigments in media containing salt or in heavy brines.

d. Blackens salted butter.

58. Pseudomonas nigrificans dd. Causes purple discoloration of salted beans.

59. Pseudomonas beijerinckii.

ddd. Reddens heavy brines (more than 18 per cent salt).
60. Pseudomonas salinaria

61. Pseudomonas cutirubra

ecc. Phosphorescent bacteria from decaying fish and crustaceans, and phosphorescent organs of sea animals.

d. Gelatin liquefied.

G2. Pseudomonas harreyi.

dd Gelatin not liquefied.

63. Pseudomonas phosphorescens.

64. Pseudomonas pierantonii.

Morphologically indistinguishable from Treponema pallidum.

Chitivable under anserobic conditions in the same medium used for Treponema pallidum.

Habitat: The cause of yaws—tropica frambesia. Patients with the disease give a positive Wassermann test. Proably transmitted by contact.

 Treponema microdentium Noguchi. (Jour. Exp. Med., 15, 1912, 81.) From Greek mikros, small and Latin, teeth.

The organism is less than 0.25 micron in thickness in the middle and tapers toward each extremity, which is pointed. The length varies with age but may reach 8 microns and show an average of 14 curves. Sometimes a long, thin flagella-like protection is observed at each extremity.

Growth occurs under anacrobic conditions in serum water medium containing fresh tissue. The serum is slightly coagulated and gives off a strong, fetud odor.

Habitat · Normal oral cavity.

4. Treponema mucosum Noguchi. (Jour. Exp Med., 16, 1912, 191; Spiro-chaeta mucosa Petiti, Contribution à l'Étude des Spirochétides, Vanves, II, 1928, 190.) From Latin, mucous

Spirals: 0 25 to 0 3 by 8 to 12 microns. The number of curves varies from 6 to 8. Both extremities are sharply pointed and often possess a minute curved projection, 8 to 10 microns long.

Cultivable under anaerobic conditions,

forming mucin.

The cultures give off a strong, putrid

odor. Takes the red in Giemsa's stain

Strict anaerobe. Source: From pus in a case of pyorrhoea.

Habitat: Found in pyorrhea alveolaris It possesses pyogenic properties.

 Treponema calligyrum Noguchi. (Noguchi, Jour. Exp. Med., 17, 1913, 96; Spirochaeta calligyra Zuelzer, 1925, in Prowazek, Hand d. path. Protoz., 5, 1931, 1673.) From M. L., with beautiful circles.

Morphology: 0.35 to 0.4 by 6 to 14 microns, average 9 to 12 microns. Spirals are regular and deep but more rounded than those of Treponema pallidum. The organism is of uniform width until near the extremities which end in sharp points with delicate projections.

Motility: Active, chiefly rotating. Stains reddish violet with Giemea's

Cultivation: Grows under anaerobic conditions.

Not pathogenie for monkeys or rabbits. Source: From smegma.

Habitat: Lesions and membranes of the pudenda.

6. Treponema genitalis Noguebi (Treponema minutum Noguebi, Jour. Exp. Med., 27, 1918, 671; not Treponema minutum Dobell, Arch. f. Protistenk., 28, 1912, 151; not Treponema minutum Dobell, Arch. f. Protistenk., 28, 1912, 151; not Treponema minutum Castellani, 1916; Noguehi, Laboratory Diagnosis of Syphilis, New York, 1923, 290; Spirochaeta minutum Zuelzer, 1925, in Prowazek, Handb. d. path. Protoz., 4, 1931, 1673; Spirochaeta genitalis Seguia and Vincent, Ann. Inst. Past., 61, 1938, 255; J. From Latin, genital.

Morphology: 0 25 to 0 3 by 3 to 14 microns. Spirals round, regular and shallow. Smaller than Tre onema pallidum and spirals are closer to other.

Motility: Active

Culture: Grows anaerobically and requires fresh tissue

Non pathogenic. Habitat: Found on male and female genitalia.

7. Treponema carateum Brumph.
(Treponema de un caso de piato, Sens.,
Grau Triana and Alfonso, Arch. de Med
Int., Havana, 4, 1933, 3; Brumpt, Compt.
Rend Soc. Biol., Paris, 150, 1939, 932,
Treponema herréjoni Léon y Blanco, Rev.
de Med. Trop. y Parasitol., Habana, 6,
1940, 5. Treponema pictor Pardo-Case
tello, Rev. de Med. Trop. y Parasitol

(Sangiorgi, Pathologica Rivista, δ, 1913, 423, Spirochaeta caviae Hindle, Med. Res. Council Syst. of Bact., 8, 1931, 174.) From the blood of a guinea pig

Spiroschaudinnia mitis Castellani and Chalmers. (Castellani and Chalmers, Man. Trop Med, 3rd ed., 1919, 451; Treponema mite Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 506.) From urine in mild cases of camp jaundice. Probably not pathogenic.

Treponema lincola (Donné) Brumpt. (Vibrio lincola Donné, Richerches Microse, Nature d. Mucus des Organs Genitournaires, Paris, 1837; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505) From secretions of the genitalia.

Genus II. Treponema Schaudinn.



in acute, regular or irregular spirals Terminal filament may be present. Some species stain only with Giemas's stain. Weakly refractive by dark field illumination in living preparations Cultivated under strictly arrectore conditions. Pathogenic and parasitic for man and animals Generally produce local lesions in tissues.

The type species is Treponema pallidum (Schaudinn and Hoffmann) Schaudinn.

1 Treponema pallidum (Schaudinn and Höffmann) Schaudinn (Sprucchaete pallida Schaudinn and Höffmann, Arb. kaiser! Gesundheitsamte, 22, 1903, 528, Schaudinn, Deutsche med. Wochnschr. 51, 1903, 1723; Spironema pallidum Vuillemin, Compt. rend Acad Sci. Paris, 140, 1905, 1567, Microspironema pallidum Stiles and Pfender, Amer Med., 10, 1905, 695, Trypanosoma luis Krzystalowicz and Siedlecki, 1905, see abst. in Bull. Inst. Past. 4, 1905, 201; Spirochaeta pallida Höffmann and Prowarek, Cent f Bikt., I Abt., 071c., 44, 1905, 741.)

Morphology Very fine protoplasmic spirals 0.25 to 0.3 by 6 to 11 microns Spiral amplitude: 1.0 micron, regular,

Spiral amplitude: 10 micron, regular, fixed

Spiral depth 05 to 10 micron.

Terminal spiral filment present weakly refrictive in Iving state by dark field illumination. May appears as series of bright date or string of ridant leads with poor dark field illumination. Staining Stain with difficulty except with General-stain by which they appear pink or rose. Appear black with silver impregnation methods.

Motility Sluggish, drifting motion, stiffly flexible, rarely rotating

Trypsin digestion Resistant for many

Bile salts (10 per cent): Disintegration complete

Saponin (10 per cent) Broken up in time

Cultivation: With difficulty under strict anaerobiosis in ascitic fluid with addition of fresh rabbit kidney.

Habitat The cause of syphilis in man. Can be transmitted experimentally to anthropoid ages and rabbits

2 Treponema pertenue Castellani, (Castellani, Jour Trop Med., 8, 1903, 233; Spirochaeta pertenuis Castellani, Jour Crojon Branch Brit Med. Assoc., June, 1903; Spirochaeta palitulula Castellani, Brit Jour. Med., 2, Nov., 1903, 1330; Spirochaeta pertenuis Lehmann and Neumann, Bakt Drug., 5 Aufl., 2, 1912, 677; Spironera pertenue Gross, Archiv f. Prolistenk, 24, 1912, 115; Treponema pelludum Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 508) From Latin, very fine.

Habana, 6, 1940, 117; Treponema pintae Curbelo, Elementos de Bacteriología Médica, 1941, 34.) From carate, spotted sickness

Description taken from León y Blanco (loc cit.)

Cylindrical 0 25 to 0 30 by 7.8 to 36 8 microns, average length 17 8 microns With sharp-pointed ends.

Spiral amplitude .1 micron, regular Spiral depth 08 to 10 micron.

Number of waves, 6 to 27, according to length Ten to twelve (Brumpt, loc cit.)

Actively motile. At times undulating or creeping movements are shown

Staining reactions Readily takes silver impregnations, Giemsa's stain, carbolfuchsin and gentian violet

Saponin (10 per cent) Disintegrates in six hours at room temperature. Same result with sodium taurocholate (10 per cent) and with bile.

Distilled water · Produces swelling Loses motility on heating for 15 minutes at 50°C or for 3 hours at 41°C.

Wassermann, Kahn and Meinicke reac

Has not yet been cultivated artificially Experimental transmission unsuccessful so far.

Source From the border of cutaneous lesions of persons having pinta (spotted sickness)

Habitat The cause of pinta (or criste) Common in Mexico and Golombra. Also found in other northern countries of South America, in Central America and the West Indies. Bare in Cuba. For subly found in other tropical regions of the world.

 Treponema cuniculi Noguchi (Spirochotzi paralus: camenti Jakobs tad, Hermatul Wehnedir, 74, 1939, 599), Noguchi, Jour Amer Med Asse, 77, 1921, 2352, abs see Noguchi, Jour Exp Med, 33, 1922, 393, Treponema pallidom var camenti Kirembeck, Cent I Bakt I Ma, Org. 87, 1921, 239, Spirochada camenti Servaliti, Marie and Istein, Compt rend Soc. Biol, Paris, 85, 1921, 51; Spirochaeta pallida var. cunculi Zuelare, 1925, in Prowavek, Handb. d. path Protoz., 5, 1931, 1765; Spirochaeta paralus Pettit, Contribution A l'Étude des Spirochaetides, Vanves, 11, 1928, 91; Spirochaeta paralus-cuniculi Hindle, Med Res. Council Syst. of Bact., 8, 1931, 187.) From Latin, rabbit.

Description from Noguchi (loc. cit). Closely resembles Treponema pallidum, but longer.

Width 0 25 micron; length 10 to 16 mi-

arrangement

erons; long specimens up to 30 microns frequent.

Spirals 8 to 12 in number, regular, deep. Spiral amplitude 1 to 1 2 microns Spiral depth 0 6 to 1.0 micron.

Delicate terminal filament at one,

sometimes both, ends
Often forms entangled masses of long
threads, occurs sometimes in a stellate

Staining properties same as for Treponema pallidum. Both readily stained by ordinary basic analine dyes when fixed in a buffered formaldeby de solution.

Wassermann reaction negative

Pathogenesis. Disease transmissible to healthy rabbits, producing papular lesions in the genitoperineal region. Not pathogenic for monkeys, nuce or guineaings.

Source · From lesions in the genitoperineal region of five rabbits

Habitat The cause of rabbit spiro-

Appendix: Many of the species in this appendix are so inadequately described that it is not certain that they belong in this group

Microapironema legeri Dulsseeq and Lebailly (Dulsseeq and Lebailly, Compt rend Med Sei Paris, 134, 1912, 1662, Treponema legeri Zuelzer, 1925, in Prowarck, Handb d jeth Protoc., 3, 1931, 1633 | Trum a fish, Rev Icops.

Spirochaeta microgyrata Loewenthal, (Loewenthal, Berl. Min, Wochnsehr., 45, 1906, 283; Spironema microgyrata Nigu1928, 911.) Pathogenic. Cause of a disease in sheep.

Treponema querquedulae Lebailly. (Compt. rend. Soc. Biol., Paris, 75, 1913, 389.) From caeca of birds. Named for the teal, Querquedula guerquedula,

Treponema rhinopharyngeum Brumpt. (Treponema rhinulum Castellani, 1916; Spiroschaudinnia minuta Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1881; Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514) Fromman in cases of rhinopharyngitis. Probably a synonym of Spirockatla gracilis.

Treponema rigidum Zinsser and Hopkins (Jour. Bact, 7, 1916, 489.) From the tissues in five different strains of rabbit syphilis. Probably a synonym of Treponema cuntculi

Treponema spermiformis Duboscq and Grassé (Arch. Zool. Expér et Gén, 66, 1927, 483) From the rectum of a termite, Glyptotermes tridipennis

Treponema squatarolae Lebailly. (Compt. rend Soc. Biol, Paris, 75, 1913, 359) From the caecum of a bird, Squatarola sountarola.

Treponema stylopygae Dobell. (Dobell, Arch. f. Prolistenk, 28, 1912, 117; Spirochacta stylopygae Zueler, 1925, in Prowazek, Handb. d. path. Protoz., 3, 1931, 1685.) From the intestines of the cockrach, Stylopyga crientalis.

Treponema tricalle Cohn. (Cohn, 1872, quoted from Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 414.)

Treponema triglae Duboscq and Lebailly. (Arch. Zool. Expér et Gén., 10, 1912, 331.) From the rectum of a fish, Trigla lucerna.

Treponema tropiduri Neiva, Marques da Cunha and Travassus. (Mem. do Inst. Oswaldo Cruz. 6, 1914, 180.) From the blood of a South American lizard, Tropidurus torqualus.

The following species are listed in the index of Castellani and Chairners, Manual of Tropical Medicine, 2 and ed., 1913, 1715-1719, but are not mentioned in the text (pp. 130-141): Treponema bovidae, T. camelidae, T. camelo, T. feldae, T. hippopotami, T. reptila, T. rhinoceri, T. selachi, T. suidae, T. ungulala and T. unsulae.

## Genus III Leptospira Noguchi.

(Jour Exp Med , 25, 1917, 753.)

Finely coiled organisms 6 to 20 microns in length Spirals 0.3 m: ron in depth and 0.4 to 0.5 micron in amplitude. In liquid medium one or both each are bent into a semicircular hook each involving ½ to 4 of the organism. Spiraling movements in liquid and vermiform in semisolid agar, forward or backward Seen in living preparations only with dark field Stain with difficulty except with Giemsa's stain and eliver impremation. Require ovegen for growth.

The type species is Leplospira icterohaemorrhagiae (Inada and Ido) Noguchi

1. Leptospita icterohaemorrhagiae (Inada and Ido) Noguchi (Eprochaeta teterohaemorrhagne Inada and Ido, Tokyo Ijishinski, 1915, Inada, Ido, Hoki, Kaneko and Ito, Jour Evp Med., 23, 1916, 377; Spirochaeta teterogenes Uhlenhuth and Fromme, Med. Kim, 11, 1915, 1202, Spirochaeta nodosa Huebner and Retter, Deutsch. med. Woebnschr, 41, 1915, 1275; Noguchi, Jour. Exp Med., 25, 1917,

755, Spiroschaudinnia ieterohaenorrhogiac Castellani and Chalmers, Man
Trop. Med., 3rd ed., 1919, 477; Treponema exterogenee Gonder and Gross, Arch.
f. Prolistenk., 39, 1919, 62; Spirochaete
ietero-hnemorrhagiac (sic) Lehmann auf
Neumann, Bakt. Ding, 6 Aufl, 2, 1820,
S10; Treponema ietero-hemorragiac (sic)
Brumpt, Nouvew Traité de Mélceine,
Paris, 4, 1922, 501; Treponema nodosum

180. Spirochaete denticola Flugge, Die Mikroorganismen, 2 Aufl., 1886, 390; Spirochaete dentium Miller, Microorganisms of the Human Mouth, Philadelphia, 1890, 80. Spirillum dentium Sternberg, Manual of Bact , 1893, 691; Spirochaeta dentium Migula, in Engler and Prantl, Die naturl Pflanzenfam., 1, 1a, 1895, 35, Spirochaeta denticola Arndt, according to Hoffmann and Prowazck, Cent f. Bakt. I Abt. Orng., 41, 1906, 819; Dobell, Arch f. Protistenk . 26, 1912, 117 . Spironema dentium Gross, Cent f Bakt., I Abt , Orig , 65. 1912. 83. Spirochaeta dentinum McFarland, Pathogenic Bacteria and Protozoa, 7th ed , 1912, 546, Treponema microdentium Noguchi, Jour Exp Med , 15, 1912, 81. Spirochaeta orthodonta Hoffmann. Deutsch med Wochnschr , 46, 1920, 257, Spirochaeta microdentium Heim, Lehr d. Bakt , 6 and 7 Aufl , 1922, 477 , Treponema denticola Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 497, Treponema orthodontum Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun. 1928, 481; Treponema dentium-stenoauratum Pettit, Contribution & l'Étude des Spirochétidés, Vanves, II, 1928, 210 ) The smallest of the mouth spirochaetes Non pathogenic This term probably includes several morphologically similar species which have not as yet been suffi ciently characterized

Treponema drosophilae Chatton (Compt rend Soc Biol, 78, 1912, 212) From Prosophila confusa Six to thirty microns in length, tapers at both ends, four spirals, movement helicoidal

Treponema gallicolum Lebailly (Compt. rend Soc Biol , Paris, 75, 1913, 389 From the caccum of the hen, Gal lut sp

Treponema hill Duboseq and Grasse (Compt rend. Soc Biol, Paris, 94, 1926, 34; Arch Zool, Expér et Gén, 68, 1927, 481) From the surface of the body of a flagellate, Derezoria hill, and in the intestine of a termite, Glyptoterms redigennis. A very small organism.

Trepanema intermedium Dobell. (Mittelformen, Lühe, Handb d Tropen-

krankh , 5, 1906, see Hoffmann and Prowazek, Cent f. Bakt , I Abt , Orig., 41, 1906, 819, Dobell, Arch f Protistenk., 26, 1912, 117, Treponema macrodentium Noguchi, Jour. Exp. Med , 15, 1912, 81; Spirochaeta media oris Hoffmann. Deutsch med. Wochnschr , 46, 1920, 257; Treponema medium Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505; Smrochaela intermedia Pettit, Contribution à l'Étude des Spirochétides, Vanves, II. 1928, 146. Spirochaeta macrodentium Pettit, ibid , 182, Spirochaeta media and Spironema media Pettit, abid . 210.) The middle-sized spirochete of the mouth

Treponema lart Lebailly. (Comptrend Soc Biol, Paris, 75, 1913, 389) Found in the caccum of birds, also in the guinea-pig. Named for one of the birds, Larus ridbundus.

Treponema minutum Dobell. (Treponema sp. Dobell, Quart. Jour. Microsc. Sci., 52, 1908, 121, Dobell, Arch f. Protistenk., 26, 1912, 151, not Treponema minutum Castellam, 1916, not Treponema minutum Noguchi, Jour Exp. Med., 27, 1918, 671. Sprochaeta minutum Zuelzer, 1925, in Promazek, Handb. d. path. Protoz., 3, 1931, 1052.) From the large intestines of toods, Bulo endgars.

Treponema parium Dobell (Dobell, Arch I Protistenk, 29, 1912, 117; Spiro-chaela parium Zueleze, 1925, in Prowarek, Handb d path Protoz, 3, 1931, 1685.) From the intestine of the cockrach, Stylopuya (Blatta, Persplaneta) orientalis. Very small organism

Treponema paionis Dubosca and Lebuilly (Arch Zool Pxpér et Gén., 10, 1912, 331) From the intestine of the blenny, Blennius pare

Treponema perezile Duboscq and Lebailly (Duboscq and Lebailly, Arch. Zool Etyfer et Gén , 10, 1012, 331; Sprochaeta perezilis Hindle, Med. Res. Council Syst. of Bact., 8, 1931, 180). From the blood of a matine fish, Lepadogaster bimaculatus.

Treponema podoris Ludovic and Blaitot (Compt. rend Acad. Sci. Paris, 187.

Morphologically indistinguishable Irom Leptospira icterokaemorrhagiae.

Cultivation: Same na Leptospira icterohaemorrhagiae.

Immunology: Some eross-reaction with Leptospira icterohaemorrhagiae, but specific in higher dilutions of immune serum.

Source: From blood of dogs.

Habitat: A natural parasite of dogs. Causes a chronic disease of old dogs characterized by uremia, not jaundice. Fatal in 80 per cent of those infected. No intermediate host known. Probably transmitted by direct contact; possibly by healthy carriers.

Appendix: The species listed below are inadequately described and may be identical with those described in full.

Leptospira aqueductum (sic) Ford. (Spirochaela pseudoicterogenes aquaeducluum Uhlenhuth and Zuelzer, Cent. f. Bakt., I Abt , Orig., 85, 1921, \*150; Ford, Textb. of Bact., 1927, 998 ) From fresh water of aqueducts Probably a synonym of Leptospira bifleza.

Leptospira asthenoalgiae Carbo-Noboa. (Bull. Inst. Past , 22, 1924, 898.) From blood, urine and organs of persons having

dengue.

Leptospira autumnalis Topley and Wil-(Akiyami Type A, Koshina, Shiwozawa and Kitayama, Japan. Med. Wld., 4. 1921, 268; see also Jour Exp. Med., 42, 1925, 873; Topley and Wilson, Princip Bact. and Immun , 1st cd , 2, 1931, 1202; Spirochaeta autumnalis A, quoted from Hindle, Med. Res. Council Syst of Bact., 8, 1931, 312; Spirochaeta autumnalis Hindle, ibid.) The cause of akiyami or harvest sickness in Japan. May be identical with Leptospira iclero haemorrhagiae.

Leptospira batarrae. (1925, quoted from Gispen and Schuffner, Cent. I. Bakt., I Abt., Orig , 144, 1939, 427.) From a case of fever in the Dutch East Indies. Probably a synonym of Leptospira hebdomadis.

Leptospira biliohemoglobinuriae (Blanchard and Lefrou) Noguchi chaeta bilio-hemoglobinuriae Blanchard

and Lefrou, Compt. rend. Acad. Sci., Paris, 175, 1922, 602; Noguchi, in Jordan and Talk, Newer Knowledge Bact, and Immun , 1928, 190.) From enses of blacknater ferer.

Leptospira bonariensis Savino and Rennella. (Rev. Inst. Bact. "Dr. Carlos G. Malbram", 12, 1944, 182.) From gray rats.

Leptospira botis Noguchi. (New York State Med. Jour., 22, 1922, 426.) From the custric mucosa of the ov.

Leptospira couryi Gomes de Faria. (Compt. rend. Soc. Biol., Paris, 90, 1924, 55; Spirochaela couryi Hindle, Med. Res. Council Syst. of Bact., 8, 1931, 317.) From the blood of persons having dengue.

Leptospira dentale Perrin. (Rev. Mex. de Biol., 2, 1922, 171.) Found in the pus

of bucco-maxillary gangrene.

Leptospira grippo-typhosa Topley and Wilson. (Topley and Wilson, Princip. Bact. and Immun., 2nd ed., 1936, 728; Spirochaela dmitrovi Rimpau, Schlossberger and Kathe, Cent. f. Bakt., I Abt Orig , 141, 1938, 320.) The cause of swamp fever in Europe. Probably synonymous with Leptospira hebdomadis. Also see Baschenin, Cent. I. Bakt, I Abt , Orig , 115, 1929, 438 and 450; Dinger and Verschaffelt, Ann. Inst. Past , 45, 1930, 396.

Leptospira haemoglobi-vriae Schäffner. (Geneesk. Tijdschr. Nr Indie, 58, 1918, 352, Spirochaela haemoglobinuriae Hindle, Med Res. Council Syst. of Bact , &, 1931, 314.) From the blood of a Javanese patient suffering from an attack of blackwater fever.

sclerohemoglobinuriae Leptospira Schüffner. (Schuffner, Geneesk. Tijdschr. v Ned. Indie, 58, 1918, 352, according to Pettit, Contribution à l'Étude des Spirochétidés, Vanves, II, 1928, Spirochaela iclerohemoglobinuriae Schuffner, Mededeel. Burgerl. Geneesk. Dienst in Nederl. Indië, 58, 1918, 7 (according to Blanchard and Lefrou, Compt. rend. Acad Sci , Paris, 175, 1922, 602); Treponema icterohemoglobinuriae Brumpt, Brumpt, ibid ,508, Leptospira icterogenes Ford, Texth of Bact., 1927, 994; Leptospira nodosa Ford, ibid., 993.) From Greek icterus, jaundice and hemorrhagiae, bleedung.

Morphology: 0.25 to 0.3 by 6 to 9 microns and occasionally 20 to 25 microns

Spiral amplitude. 0.4 to 0.5 micron, regular, rigid.

Spiral depth: 03 mieron, regular.

Waves: One or more gentle waves throughout entire length. When in liquid media, one or both ends may be semicircularly hooked, while in semisolid media the organism appears serpentine,

waved or bent. Very active flexibility. Terminal filament and flagella absent. Body stains reddish by Giemsa's stain Bile salts (10 per cent): Easily dis-

solved
Sanonin (10 per cent): Easily dis

Saponin (10 per cent). Completely resistant

Cultured easily in medium containing 10 per cent rabbit serum, 0.2 per cent agar, slight amount of hemoglobin in salt or Ringer's solution. Does not grow in surface rolonics

Temperature range: 25° to 37°C Remains alive longer at 25°C.

Pathogenic for guinea pigs and deer-

Habitat The cause of infectious jaundice in man (Weil's disease) Found in the kidneys, urine and blood of wild rats No insect vector known Found free living in water and slime (in mines)

2 Leptospira hebdomadis (Ido et al.) Noguchi. (Spirochaeta nanakapani Ido, Iloka, Ito and Wani, Nippon Gakkai Zasahi, 5, 1917, No. 5, Spirochaeta hebdomadis. Ido, Ito and Wani, Jour. Exp. Med., 28, 1918, 433, Spirochaedinine hebdomadis. Castellani. and Chalmers, Man. Teop. Med., 3ed., 1919, 418, Orguchi, Jour. Exp. Med., 59, 1919, 17; Treponena hebdomadis. Brumpti, Nouvesu. Traité de Médecine, Paris, 4, 1922, 2013. From Iatin, seven days. Morrholociesity indistinguishable from Morrholociesity indistinguishable from Morrholociesity indistinguishable from

Morphologically indistinguishable from

Leptospira icteroheamorrhagiae but can be distinguished scrologically.

In man causes less jaundice than Leptospira icterohaemorrhagiae and is never fatal.

Identical with Type B, Leptospira autumnalis.

Slightly pathogenic for young guinea pigs.

Is carried by the field vole (Microtus montibelli)

Habitat: Cause of seven-day fever or gikiyami in Japan

3 Leptospira biflexa (Wolbach and Binger) Noguchi. (Spirochaeta biflexa Wolbach and Binger, Jour, Med. Res , 50. 1914, 23; Noguchi, Jour Exp. Med., 27, 1918, 585; Spirochaeta pseudo-icterogenes (aquatilis) Uhlenhuth and Zuelzer, Cent. f. Bakt., I Abt., Orig . 85, 1921. 141; Spirochaeta pseudoicterogenes Uhlenhuth and Zuelzer, Klin. Wochnschr., 1, 1922, 2121; pseudo-icterohemorrhagiae Spirochaeta Vinzent, Compt. rend. Soc. Biol , Paris, 95, 1926, 1472; Leptospira pseudoicterogenes Noguchi, in Jordan and Falk, Newer Knowledge Bact, and Immun , 1928, 461.) From Latin, doubly bent.

Size: 0 2 to 0 25 by 5 to 7 microns with tapering ends Spiral amplitude 0 2 to 0 25 micron. Will pass through an 1.5 candle filter.

Waves 22 to 30 in number.

Stains: Best results with Giemea's stain

Culture Can grow in distilled water plus 0.1 per cent potassium nitrate. Rabbit serum in distilled water is best medium

Optimum temperature 20°C.

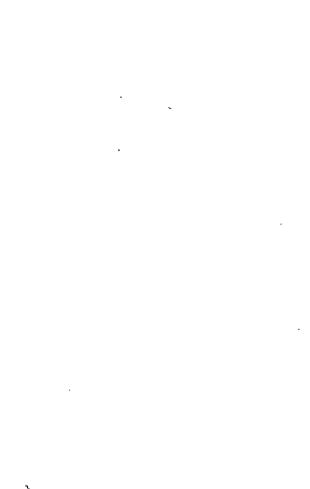
Antigenically distinct from Leptospira scterohaemorrhagiae.

Not pathogenic

Source From tap water, ponds and pools in Berlin

Habitat : Fresh water.

4 Leptospirs canicola Okeli et al. (Okell, Dalling and Pugh, Vet. Jour, 81, 1925, 3) From Latin, dog-dweller.



Nouveau Traité de Médecine, Paris, 4, 1922, 501) From the blood in a case of blackwater fever.

Leptospira interrogans (Stimson) Noruchi (Spirochaeta interrogana Stimson, U S Public Health Rept . Part I. 23. 1907, 541, Leptospira icteroides Noguchi, Jour Exp Med , 29, 1919, 581; Treponema interrogans Brumpt, Nouveau Truté de Médecine, Paris, 4, 1922, 505. Treponema actoroides Brumpt, ibid ; Spirochaeta acteroides Lehmann and Neumann, Bakt Ding , 7 Aufl , 2, 1927, 576, Noguchi, in Jordan and Falk, Newer Knowledge Bact and Immun , 1928, 454 ) Noguchi (1928) regards this species as identical with Leptospira icterohacmorrhagiae

Leptospira petitis (Fiessinger) Hindle (Spirochaete petitis Fiessinger, Ann de Méd. 5, 1918, 156, Treponema petitis Brumpt, Nouveau Traité de Médeene, Paris, 4, 1922, 510, Hindle, Med Res Council Syst. of Baet., 3, 1931, 316, Spirochaeta petitis Hindle, idem, not Spirochaeta petitis How, Jour. Trop Med and Hig, 1922, 361). From urine Morphologically indistinguishable from Lepto spira eterokaemorrhagiae

Leptospira pyrogenes Vervoort. (Ver voort, Geneesk, Tujsker, Ved. Indis, 65, 1923, 800, Spirochaeta febrils Vervoort, Rep. Far Last Assoc Trop Med., London, 1923, 683; Spirochaeta pyrogenes Ilindia, Med Res Council Syst of Bact, 8, 1933, 343) From the blood of persons suffering from dengue like fevera in Sumatra. Pathogenie

Leptospira sarkoebing Petersen (Acta Path et Microbiol. Scand, 21, 1944, 165) A new serological type.

Leptospira salina Foni (Spirochaeta pseudoicterogenes salina Uhlenhuth and Zuclzer, Cent. f. Bakt, I Abt, Orig, 85, 1921, \*150, Ford, Textb. of Bact, 1927, 998) From salt water.

Leplospira trimerodonta (Hoffmann) Noguchi (Spirochaeta trimerodonta Hoffmann, Deutsch med. Wochnschr.; 46, 1920, 237, Leplospira dentum Hoffmann, tol., 625; Leplospira buccilis Fontana, according to Pettit, Contribution à l'Étude des Spirochétudes, Vanves, II, 1928, 232; Noguchi, in Jordan and Falk, Newer Knowledge Bart, and Immun, 1928, 461) 1 From the oral cavity. May be synonymous with Leplospira sicterbalement-house.

Spirochaeta anthropopitheci Wilbert and Delorme (Ann. Inst. Past., 41, 1927, 1147.) Pathogenic for chimpanzes in French Guinea Probably identical with Leutanura iclerohaemorrhagas.

Spirochecta clusa Wolbach and Binger (Wolbach and Binger, Jour Med Res, 59, 1914, 9, Treponema clusum Bergey et al., Manual, 1st ed., 1923, 428) From pond water. Not pathogenic For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 959.

Spirochaeta ietero-uraema canis Klarenbeek (Tijdschr Diergeneesk, 55, 1928, 227) From the kidneys of dogs. Pathogenic for guinea pigs. May be synonymous with Leptopira ieterohaemorrhagus or L canicola

Spirochaeta pseudohebdomadis Zuelzer. (1925, in Provazek, Handb d. path. Protoz , 5, 1931, 1671) Protobly identical with Leptorpura hebdomadis

Spirochaela trimeres Hoffmann. (Deutsch med Wochnschr. 49, 1920, 257.) From the oral cavity. May be synonymous with Leptospira trimerodonta

- III. Plant pathogens, causing leaf spot, leaf stripe and similar diseases.
  - Green fluorescent pigment produced.
    - a. Gelatin liquefied.
      - b. Acid from sucrose.
        - c. Nitrites produced from nitrates.
          - 65. Pseudomonas martuniae.
          - 66. Pseudomonas striafaciens.
        - 67. Pseudomonas tomato. cc. Nitrites not produced from nitrates.
        - - d Growth in 5 per cent salt.
            - 68. Pseudomonas aceris.
              - 69. Pseudomonas anaulata.
              - 70. Pseudomonas aptata.
              - Pseudomonas primulae.
              - Pseudomonas viridilivida.
          - dd. No growth in 5 per cent salt e. Beef peptone agar turns brown.
            - 73. Pseudomonas delphinii.
            - ce. Beef peptone agar uncolored.
              - 74. Pseudomonas berberidis.

              - 75. Pseudomonas coronafaciens.
              - 75a. Pseudomonas coronafaciens var. atroриритеа.
              - 76. Pseudomonas lachrymans.
              - 77. Pseudomonas maculicola.
              - 78. Pseudomonas marginata.
              - 79. Pseudomonas medicaginis.
              - 79a. Pseudomonas phaseolicola.
              - 80. Pseudomonas pisi.
              - 81, Pseudomonas syringae,
          - ddd. Growth in salt solutions not recorded.
            - 82. Pseudomonas atrofaciens.
            - 83. Pseudomonas cumini.
            - 84. Pseudomonas desaiana.
            - 85. Pseudomonas erodii.

            - 86. Pseudomonas apii. 87 Pseudomonas matthiolae.
            - 88. Pseudomonas mors-prunorum.

            - 89. Pseudomonas rimaefaciens.
            - 90. Pseudomonas papulans.
            - 91. Pseudomonas pseudozoogloeae.
            - 92. Pseudomonas tabaci.
        - ecc Nitrite production not reported. 93. Pseudomonas lapsa.
      - bb. No acid from sucrose.
        - c. Nitrites produced from nitrates.
          - 94. Pseudomonas bowlesiae.
            - 95. Pseudomonas intybi.
              - 96. Pseudomonas marginalis.
            - 97. Pseudomonas setariae.

## SUPPLEMENT NO. 1.

# ORDER RICKETTSIALES



#### ORDER RICKETTSIALES GIESZCZYKIEWICZ

(Bull, Intern Acad, Polon, Sci., Classe Math. Nat., B(1), 1939, 9-30.)

Small, rod-shaped, occoid, spherical and irregularly-shaped microorganisms which stain lightly with aniline dyes. Gram-negative. Usually not filterable. Cultivated outside the body, if at all, only in living tissue, embryonated eggs or rarely in media containing body fluids. Parasitic organisms intimately associated with tissue cells and erythrocytes, chiefly in vertebrates and often in arthropods which act as vectors. The intracellular parasites of Protozoa may also belong here. May cause diseases in man or a nimals, or both.

#### Key to the families of order Rickettsiales.

- Intracellular parasites, or parasites intimately associated with tissue cells.
   Do not occur in crythrocytes Frequently cause diseases of vertebrates transmitted by arthropod vectors
- II Facultative intracellular or extracellular parasites found characteristically in or on the crythrocytes of vertebrates May be transmitted by arthropod vectors.

  Family I Bartonellaceae, p. 1103.
- Intracellular parasites found in vertebrate tissues and not transmitted by arthropod vectors.

Family III Chlamydozoaceae, p 1114.

### \*FAMILY I RICKETTSIACEAE PINKERTON.

(Pinkerton, Parasitology, 28, 1936, 186, Richettsiales Buchanan and Buchanan, Bacteriology, 4th ed., New York, 1938, 49)

Small, often pleomorphic, rod-shaped, ovoid, eoceoid and coccus-shaped beteriumlike organisms, intimately associated with arthropod tissues, usually in an intracellular position. Stain lightly with aniline dyes. Gram-negative. Have not been cultivated to date in cell-free media. May be parasitive to man and other animals causing diseases (typhus and related ills) that are transmitted by arthropod vectors (lice, fleas, ticks, mites and probably other ectoparasites).

### Key to the genera of family Rickettsiaceae.

I Cells rod-shaped, ellipsoidal and coccoid A Non-filterable.

Genus I Rickettsia, p. 1081.

B Filterable.

Genus II Coriella, p. 1002.

II Cells spherical, occasionally elongated.

Genus III. Coudria, p. 1091.

Prepared by Dr. Ida A. Bengtson (retired), National Institute of Health, Bethevsky, Maryland, November, 1916. Through the courtery of Dr. Edward A. Steinhaus much use was made of material from his book, Insect Microbiology, Ithaca, 1916, 763 pp. before it was generally available.

<sup>†</sup> Includes only those rekettsiae which have been rather completely studied. For additional rickettsiae, see appendix.

## Genus I. Rickettsia da Rocha-lama.

(Berl. klin. Wehnschr., 55, 1916, 567-569.) Named for Howard Taylor Ricketts who lost his life studying typhus fever.

Small, often pleomorphic, rod-shaped to coccoid organisms occurring intracyto-plasmically in lice, fleas, ticks and mites, or sometimes intranuclearly. Stain lightly with amiline dyes. Gram-negative. Non-filterable. Have not been cultivated in cell-free media. Parasites of man and animals which are the ctiological agents of epidemic typhus, murine or endemic typhus, Rocky Mountain spotted fever, tsu-tsugamushi disease, rickettsialpox and other diseases.

For reasons that are discussed elsewhere (Bengtson, Jour. Bact., 63, 1947, 325) the genus Dermocentrozenus has been united with the genus Rickettsia.

The type species is Rickettsia prowazekii da Rocha-Lima.\*

## Key to the species of genus Rickettsia.

- I. Louse-horne.
- II Flea-borne
- III. Tick-borne.
- IV. Mite-borne.

- Rickettsia prowazekii.
- 2. Rickettsia tuphi.
- 3. Rickettsia rickettsii
- 4. Rickettsia conorii.
- 5. Rickettsia tsutsugamushi.
- 6. Rickettsia akari.

1. Rickettsia prowazekii da Rocha-Lima. (da Rocha-Lima, Berl. klin Wehnsehr, 55, 1916, 667; Rickettsia ezanthemotolyphi Kodama, Kitasato Arch Exper. Med., 9, 1932, 360, Rickettsia prowazeki var. prowazeki Pinkerton, Parasitology, 28, 1936, 186; Rickettsia prowazeki valu-species prowazeki Pinkerton, Orocazeki valu-species prowazeki Philip, Amer. Jour. Hyg., 37, 1943, 307.) Named for S von Promazek who lost his life studying typhus fever.

Minute coccoid, ellipsoidal and ovoid forms to short rods, sometimes long rods and occasionally filamentous forms, often in pairs and occasionally in chains. In infected lice the minute coccoid and

paired coccoid forms predominate over the short and long rods and the filamentous forms which are up to 40 microns in length. Single elements 0.25 by 04 to 0.3 by 0.45 micron Pairs range from 025 by 0.7 to 03 by 1.1 microns. In volk sacs the organisms v ry in size from minute coccoid forms in | eavily infected tissue to rod forms resembling small bacteria in lightly infected tissue. Within the same smear of infected mammalian cells and in chick embryo tissue the organisms are quite uniform in size and morphology. Occur intracytoplasmically in vascular endothelial cells and in serosal cells. Non-motile.

- or

low

modern patronymics based on all other names of men-

<sup>\*</sup> The Editors of the Manual follow Recommendation XL of the International Botanical Code (see p. 59) in regard to the endings used for specific names. This calls for the use of the ni ending for epithets taken from the name of a man ending in a co

The organisms are colored purplish with the Giemas stain, the two individuals of a pair being connected by a zone of faintly blue stanned material They are colored blue with Castafocka stain (Jour. Inf. Dis., 47, 1930, 416) and bright red against a blue background with Machiavello stain (Rev. Chilena de Hig y Med Prev. 1, 1937, 101) Grammentive

Cultivation In plasma tissue cultures of mammalian cells, in the louse intestine, in modified Maitland media with and without agar, on choric-aliantoic membrane and yolk sac of chick embryo, the latter being currently the medium of choice.

Optimum temperature 32°C in plasma tissue culture, 35°C in chick embryo cells

Immunology: Immunity prolonged but may not be complete in man tinguishable from endemic (murine) typhus in cross immunity tests in guinea pigs, but distinguishable from Rocky Mountain spotted fever and other rickettsal discuses in such tests Neutralizing antibodies are found in the serum of recovered guinea pigs and convalescent humans up to 2 to 3 weeks after defervescence Killed saccines produced from infected lice and from infected volk sacs afford a high degree of protection against the disease. Hyperimmune antisera for therapeutic use have been produced in rabbits by injection with infected yolk sae suspensions and in horses and donkeys with infected mouse lung suspensions

Scrology Strains from various parts of the world are closely related as determined by complement fixation, are distinguishable from other ricketsiae by agglutnation, complement fivation and precipitin tests; have a common antigenic factor (alkalı stable polysaccharide) with Proteus OX19; and have a soluble antigen in yolk culture.

Lethal effect Heavily infected yolk sac cultures injected intravenously or intraperitoneally are fatal to white mice in a few hours.

Resistance to chemical and physical agents: Readily inactivated by heat and chemical agents. A temperature of 50°C kills the organism in 15 to 30 minutes, and 0.5 per cent phenol and 0.1 per cent formalin kill the organism.

Pathogenicity: Pathogenic for man, apes, monkeys, gunea pigs, cotton rats, gerbilles, the louse (Pediculus humanus). Inapparent infections occur in white mee, white rats and rabbits A characteristic febrile reaction with no mortality and without testicular suchling occurs in the gunea pig Passage in gunea pigs is accomplished by transfer of blood or brain from infected animals. Causes a febrile disease with exanthema and high mortality in man

Source Seen in the blood of typhus patients and in smears of epithelial cells of the intestinal tract of lice fed on typhus rationts

Habitat-The body louse (Pediculus humanus var corporss), head louse (Pediculus humanus var capitis) and Pedicinus longiceps The etological agent of epidemic typhus (European typhus, classical typhus, typhus exanthematicus).

2 \*Rickettsia typhi (Wollach and Todd) Philip. (Dermacentrozenus

Some may regard the binomial Relection typhs as invalid because of its previous use by do Amaral and Monteiro for the organism causing eastern Rocky Mountain spotted fever. However, because the binomial Democrationeous typh Wollach and Todd clearly has provity and because the binomial proposed by do Amaral and Monteiru has never rome into general use. Reletting they Public has been accepted for use in the Maxa st.—If Philip's binomial had been rejected, then it would have been necessity to accept Richtful monthurae Kodama et al. as this appears to have priority over the more generally used Richtful monociery Monteiry—Pathors.

typhi Wolbach and Todd (not Tood), Ann. Inst. Past., 54, 1929, 158; minute intracellular bodies, Mooser, Jour. Inf. Dis., 48, 1928, 261; Rickettsia manchuriae Kodama, Takahashi and Kono, Saikingaku-Zasshi (Jap.), No. 426, 427, Aug. and Sept., 1931; see Kodama, Kono and Takahashi bibliography, Kitasato Arch. Exper. Med., 9, 1932, 95; Rickettsia mooseri Monteiro, Mem. Inst. Butantan. 6, 1931, 97 (pub July, 1932), see do Amaral and Monteiro, bibliography, ibid., 7, 1932, 367; Rickettsia exanthematofebri Kodama, Kitasato Arch Exp. Med., 9. 1932, 360; Rickettsia muricola Monteiro and Fonseca, Brazil Med., 46, 1932, 1032; Richettsia murina and Richettsia fletcheri Megaw, Trans. Roy. Soc. Tron. Med. Hyg., 29, 1935, 105; Rickettsia prowazeki var. mooser: Pinkerton, Parasitology, £8, 1936, 185; Rickettsia prowazeki sub-species typhi Philip, Amer. Jour. Hyg , \$7, 1943, 304; Rickettsia typhi Philip, idem; not Rickettsia tuphi do Amaral and Monterro, Rev Sud. Amér de Méd. et Chirug , 4, 1933, 806.) From M. L. typhus, typhus.

Resembles Richettsta prowazeln in morphological and staining properties Non-motile Gram-negative

Cultivation May be cultivated in plasma tissue culture of mammalian cells, in modified Maitland media with and without agar, in fleas, in the pentoneal cavity of X-rayed rats, in the lungs of white mice and in white rats following intranasal inoculation, in the lungs of rabbits following intratracheal inoculation, in the chorio-allantoic membrane and the yolk sac of the chick embryo.

Optimum temperature 35°C in chick embryo cells.

Immunology: Prolonged immunity in man and animals following infection Complete cross immunity between epidemic and endemic typhus in guinea pigs recovered from infections with Rickettsia provaziehi and Rickettsa typhi. No cross immunity between endemic typhus and Rocky Mountain spotted fever, Q fever or tsutsugamushi disease in guinea pigs.

Serology: Distinguishable from the rickettsiae of spotted fover, Q fever and tsutsugamushi disease by complement fination, agglutination and precipitin tests, less readily from R. proruzelhi by these tests. Has common antigenic factor with Proteus OX19, and soluble antigen in yolk-sae cultures.

Lethal effect: Heavily infected yolk sac cultures injected intravenously or intraperitoncally fatal to white mice in a few bours.

Pathogenicity: Pathogenic for man. apes, monkeys, rabbits, guinea pigs, white rate, eastern cotton rat, white mice, gerbilles Other susceptible animals include the woodchuck, house mouse, meadow mouse, white-footed mouse, old-field mouse, cotton mouse, golden mouse, wild rat (Rattus norvegicus), wood rat, rice rat, flying squirrel, gray squirrel, for squirrel, gophers, cotton-tail rabbit, swamp rabbit, chipmunk, skunk, opossum and cat. A characteristue febrile reaction occurs in the guines pig with testicular swelling without ulceration, after intraperitoneal inoculation. Passage in guinea pigs is accomplished by transfer of testicular washings or blood from inferted animals Cause of a febrile disease with exanthema in man, with low mortality.

Source: Seen by Wolbach and Todd (loc. cit ) in the endothelial cells of the capillaries, arterioles and veins in sections of skin from cases of Mexican typhus (tabardillo). Also described by Mooser (loc. cit.) in sections and emears of the proliferated tunica vaginalis of guines pigs reacting to the virus of Mexican typhus.

Habitat: Infected rat fleas (X-nopsylla cheopis, X-enopsylla astia), infected chicken fleas (Echidnophaga gulinacea) found on wild rats, and the rat louse (Polyplax spinulosus). Wild rats and field mice act as the reservoir of infection. The etiological agent of endemic (mut ne) typhus which is transmitted to man by the rat flea.

3. Rickettsia rickettsii (Wolbach) Brumpt. (Dermacentroxenus ricketts: Wolbach, Jour. Med. Res., 41, 1919-20, 87; Rickettsia rickettsi Brumpt, Précis de Parasitologie, 3rd ed., 1922, 757, Rickettsia braziliensis Monteiro, Mem Inst. Butantan, 6, 1931, 3; \*Rickettsia tuphi do Amaral and Monteiro, Rev Sud Amér. de Méd et Chirurg , 4, 1933, 806, Dermacentrozenus richettsı var. brasiliensis Pinkerton, Parasitology, 28, 1936, 186.) Rickettsia dermacentroxenus, a corruption of Dermacentrorenus rickettss. though widely used, has no genuine taxonomic standing. Named for Howard Taylor Ricketts, who first transmitted the disease from human cases to monkeys and guines pies with the production of characteristic symptoms and lesions and fatal effect.

Minute paired organisms surrounded by a narrow clear zone or halo and often lanceolate, resembling in appearance a minute pair of pneumococci. Approximately 0 2 to 0 3 micron by 1 micron. Non-motile

In smears of mammalian tissues there occur in addition to the lanceolate forms. slender rod-shaped forms stained blue with the Giemsa stain, sometimes evhibiting polar granules, stained purplish or reddish. There are also minute pale blue-staining rounded forms. In the tick there are three forms: (1) Pale blue bacillary forms curved and club-shaped, (2) smaller bluish rods with deeply staining chromatoid granules and (3) more deeply staining, purplish, lanceolate forms. A very minute form may appear in tightly packed masses in the nuclei of the cells. Occurs in the cytoplasm and nucleus in all types of tissuo in the tick and in the vascular endothehum, in the serosal cells of the peritoneal cavity, in the smooth muscle cells of arteriolar walls and in the macrophages of mammals.

In yolk sac cultures and in the Maitland media cultures, bacillary forms often occur in pairs. In single smears from infected yolk sacs, the rickettsiae are rather uniform in size and morphology and are definitely larger than Rickettsia procazekii and Rickettsia typhi. They also grow more sparsely. Stain blue with the Castafieda stain and bright red against a blue background of tissue with the Machiavello stain

Cultivation May be cultivated in plasma tissue culture of mammalisan cells, in Maltand media with and without agar, on the chorio-allantoic membrane and in the yolk sac of the chick embryo, and in ticks.

Optimum temperature 32°C in plasma tissue culture, 35°C in chick embryo cells.

Immunology, Prolonged immunity in man and animals after recovery from infection. Killed vaccines produced from infected ticks and from infected volk sacs afford considerable protection accurat the disease. Therapeutic antisers have been produced by the injection of rabbits with tick virus and with infeeted yolk sac. No cross immunity between spotted fever in guinea pigs recovered from infections with Rickettsia rickettsii and typhus in guinca piga recovered from infections with Rickettain prowazekis and Rickettsia typhi. Cross immunity between spotted fever in guinea pigs recovered from infections with Rickettsia rickettsii and bouton. neuse fever in guinea pigs recovered from infections with Ricketteia conorii, but snotted fever vaccine does not protect against boutonneuse fever of the Mediterrancan area or against infections with the South African strains of RicLetteia conorsi

<sup>\*</sup> Erroneously applied by do Amarsl and Monteiro to the so-called castern type of Rocky Mountain spotted fever.—Editors.

Serology Distinguishable from Rickettisa prowazeki and Rickettisa-typhi by complement fixation and agglutination with specific antigens. Distinguishable from Rickettisa cororii by complement fixation, though some degree of cross fixation indicates antigenic relationship. Has common antigenic factor with Proteus OX19 but not distinguishable from Rickettsia prowazeki and Rickettsia typhi by Weil-Felix test.

Resistance to chemical and physical agents: Readily inactivated by heat and chemical agents. Destroyed by a temperature of 50°C in 10 minutes, and by 0.5 per cent phenol and 0.1 per cent formalin. Destroyed by desiccation in about 10 hours.

Pathogenicity: Pathogenic for man, monkeys and guines pugs. Rabbits and white rats are moderately susceptible. Animals susceptible in varying degrees include species of ground squirrels, tree sinclude species of ground squirrels, tree squirrels, chipmunks, cotton-tail rabbits, jack rabbits, snowshoe rabbits, marmots, wood rats, weasels, meadow mice and deer mice. In Brazil the opossum, rabbit, dog and eavy have been found naturally infected and the Brazilian plains dog, capybara, coati and certain bats are also susceptible susceptible.

A febrile reaction occurs in guinea pigs with typical scrotal lesions, involving petechial hemorrhages in the skin, which may become neerotic. Virulent strains kill 80 to 90 per cent of the animals, milder strains kill 20 to 25 per cent. Passage in guinea pigs is accomplished by transfer of blood from infected animals. A febrile reaction accompanied by evanthems occurs in man. Mortality is high in some localities, low in others.

Source Seen by Ricketts (Jour. Amer. Med Assoc, 58, 1909, 379) in the blood of guinen pigs and monkeys experimentally infected with Rocky Mountain spotted fever and in the salivary glands, alimentary sac and ovaries of infected

female Dermacentor ticks and in their ova.

Habitat: Infected wood tick (Dermacentor andersoni) and the dog tick (Dermacentor variabilis), also the rabbit tick (Haemaphysalis leporis-palustris), Amblyomma brasiliensis. Amblyomma cajennense, Amblyomma striatum, Amblyomma americanum and Izodes dentatus. A number of ticks belonging to the genera Amblyomma, Dermacentor, Rhipicephalus, Ornithodoros and Haemaphysalis have been experimentally infected. The virus is transmissible through the ove of female ticks. The etiological agent of Rocky Mountain spotted fever. Sac Paulo exanthematic typhus of Brazil, Tobia fever of Colombia and spotted fever of Minas Gerses which are all transmitted to man by the bite of infected ticks.

4. Rickettsia tiragoa Brumpt. (Brumpt, Compt. rend. Soc. Biol., Paris, 110, 1932, 1199; Rickettaia megawi var. priperi do Amarai and Monteiro, Mem. Inst. Butantan, 7, 1932, 361; Rickellina blancs Caminopétros, 1er Cong. Internat. Hyg. Mediterr, Rapports et Compt. rend., 2, 1932, 202; Dermacentroxenus rickettsi var. pipperi Mason and Alexander, Onderst, Jour. Vet Sci. and An. Indust , 15, 1939, 74; Dermacentrozenus richettsi var. conori Mason and Alex ander, ibid; Dermocentroxenus conori Steinhaus, Insect Microbiology, 1946, 339.) Named for A. Conor who with A. Bruch published in 1910 the first clinical description of boutonneuse fever.

Resembles Rickettsia rickettsii. In the tick, diplococcoid and diplobarillary forms predominate, though when the rickettsias occur in compact masses they are smaller and more coccoid. In tissue cultures the organisms are lanceolate, diplococcoid, and diplobacillary, occurring in the nuclei as well as in the cytoplasm of the cells. Size 0.3 to 9 to 1 to 175 microns. Non-motile.

Stain purplish with the Giemsa stain,

blue with the Castaued, stain and bright red with a blue background with the Machiavello stain. Gram-negative.

Cultivation May be cultivated in plasma tissue culture of mammalian cells, in modified Maitland media, and in the volk sacs of chick embryos.

Immunology: The disease is related immunologically to Rocky Mountain spotted fever with which it cross immunizes, but the spotted fever vaccine does not protect against the Mediterranean and South African strains of boutonneuse fever.

Serolegy: Distinguishable from Rickettsia rickettsii by complement fixation Has a common antigenic factor with Proteus ON19 and ON2.

Pathogenicity: Pathogenic for man and gumea pigs. It is also pathogenic in varying degrees for dogs, horses, spermophiles, monkeys, rabbits, gerbilles and white mice.

Boutonneuse fever is a much less virulent infection for the guinea pig than Rocky Mountain spotted fever. A temperature reaction occurs, accompaned by serotal swelling but there is no sloughing. There is practically no mortality Passage in guinea pigs is accomplished.

by transfer of blood from an infected animal.

In man, localized primary sores (taches noires) and an inflammatory reaction in the regional lymph nodes occur at the site of the tick bite. A febrile reaction with evanthems occurs and mortality is low

Source Seen by Cammopétres (Compt. rend. Soc. Biol., Paris, 110, 1932, 311) in smears from the tunica vaginalis of guinea pigs moculated with infected dog ticks (Rhipteephalus sanguineus).

Habitat: The brown dog tiek (Rhipi-cephalus sanguneus) and also the tieks, Arablgorum hebracum, Haemaphyadis teachi, Rhipicephalus appendiculatus and Bošphilus decoloratus. Transmissible through the ova of adult female tieks. The probable animal reservoir is the dog. The etiological agent of boutonneuse fever in man, also known as eruptive, Mediterranean or Marseilles fever and probably Kerna typhus and South Africant tiek bite fever, though the klentity of the latter with boutonneuse fever has been questioned

5 "Rickettsia tsutsugamushi (Hayashi) Ogata (Theileria tsutsugamushi

"Some may question the use of this hinomial on the ground that Hayashi thought that this species was pessibly or probably prototean in nature when he proposed the name Theileria Intergramush (loc. cit) in 1920. However be questions whether Theileria is the correct generic name in this priparand accepts the viewpoint that this organism is a rickettisi in a paper published in 1921 entitled. On flickettisi, Trans Jap Path. Soc., 14, 1921, 198-201. He does not use the binomial Rickettian Intuluyimushi in this paper as indicated by some of his friends in bitter papers (Ogsta, ke cit, Kawamura, loc. cit.) and apparently first uses it himself in a paper entitled, On Trustusymushi Direase Jan Path Soc. 2, 1932, 609.

Hayashi was not the first to recume the probable neketical nature of the organism of the tutusgamuchi disease (see Blakectal., Amer Jour Hyg. 41, 1915, 257-250) and some even question whether any of the bodies that he found in human lymphoeytes from lymph nodes, in mononuclear endothelial phayocytes of the apleen and lymph nodes, and in inseuser sides from the region of the mits but in princints sufficing from tutusgamuchi fever were the same as organisms described as Riel ithin orientalis by Naryo et al. (be. cit.)

This position is not supported, however, by Nagavo and his associates who admit their organisms are identical with some of the organisms described by Hayada. Mitamura (Trans. Jap Path Sec. 24, 1911), 400 sums this was followed Wirelder.

Hayashi, Jour. Parasit., 7, 1920, 63; \*Rickettsia orientalis Nagayo, Tamiya, Mitamura and Sato, Jikken Igaku Zasshi, 14, May 20, 1930. 8 pp.: †Rickettsia isutsugamushi Ogata, Cent. f. Bakt., I Abt., 122, 1931, 249; Rickettsia akamushi Kawamura and Imagawa, ibid , 122, 1931, 258. Rickettsia orientalis var schaffneri do Amaral and Monteiro, Mem Inst. Butantan, 7, 1932, 360; Rickettsia megawi do Amaral and Monteiro, idem: Rickettsia megawi yar, fletcheri do Amaral and Monteiro, abid., 361, Rickettsia tsutsugamushi-orientalis Kawamura, Nisshin Igaku, 23, 1934, 000: Rickettsia nzeudotunhi Veryoort, see Donatien and Lestoquard, Acta Conv. Tertii Trop. atque malariae morbis, pars I, 1938. 564; Rickettsia sumatranus (sic) Kouwenaar and Wolff, Proc 6th Pacific Sci. Cong. (1939), 5, 1942, 636; Dermacen-

tracenus orientalie Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in modern biology), 19, 1945, 12)
From two Japanese ideographs transiterated tsutsuga, something small and dangerous, and mushi, a creature now known to be armite. If the i ending is accepted as forming a Latin genitive the modern meaning of the species name sutsugamushi, would be 'of a dangerous mite'

Small pleomorphic bacterium-like microorganisms, usually thicker than Rickettsia procatzekii, Rickettsia typhi, Rickettsia rickettsii and Coxiella burnetii and less sharply defined. Ellipsoidal or rodshaped, often appearing as a dipleoceus or as a short bacillus with bipolar staining resembling the plague bacillus. Diffusely distributed in the cytopiasm of the cell. Size 0.3 to 0.5 bv 0.8 to 2

nicht in Abrede dass Herr Hayashi bei einem kleinen Teil der von ihn beschriebenen Körperchen unsere Ricketteia orientalis vor sich gehabt hat". Hayashi vigorously defends his own observations in the same discussion and the following year after making comparative studies of strains of Rickettsia erientalis and his own Rickettsia tsutsugamushi reaches the following conclusion (loc. cil.) "Rickettsia tsutsugamushi and Rickettsia orientalis refer to one and the same species of microorganisms and there seems to be no way in which one can be recognized as differing from the other." Under these conditions the only valid name appears to be Rickettsia Isutsugamushi.—Editors.

\* These authors publish practically the same preliminary paper in three other places as follows: Compt. rend. Soc. Biol., Paris, 104, June 14, 1930, 637-641; Jsp. Jour. Exper. Med , 8, Aug. 20, 1930, 309-318 and Trans. Jap. Path. Soc., 20, 1930, 556-566. The complete report on this work did not appear until the following year: Jap. Jour. Exper. Med , 9, March 20, 1931, 87-150 —Editors.

† This binomial apparently first appears in the literature in a review article by Kawamura (Handbuch der path. Microorganismen, Kolle and Wassermann, 3 Auß., 8, 1330, 1393) where it is used incidentally and is attributed to Hayashi, 1223. The fact that Hayashi did not use Ricketsia trutungamushi before 1931 is confirmed by Mitamura (Trans Jap. Path. Soc., 21, 1931, 463) who states in a footnote Kawamura und Ogata geben an, dass Hayashi 1923 fur den Erreger den Namen Rickettina tuitungamushi vorgeschlagen hat. Eine solche Angabe Hayashi, is nicht nur uns, sondern auch dem Autor, wie er uns personitech errahlt, unbekannt." Ogata apparently first used Rickettina trutungamushi in the title of a paper that he presented in 1930 to the 8th Cong. Far East Assoc. Trop Med. which, however, appeared in the Transactions of the Congress, 9, June, 1932, 167-171 Meanwhile, the same paper with an added discussion of the nomenclature appeared in the Cent. f. Bakt., I Abt., Orig., 122, Oct. 1, 1931, 249-253 and it is this paper that is usually regarded as establishing the use of Rickettisia tsutungamushi for this species.—Editors.

cc. Nitrites not produced from nitrates.

d. Lipolytic.

98. Pseudomonas polycolor. dd. Not lipolytic.

99. Pseudomonas viridiflara

993. Pseudomonas viridiflasa var. concen-

ddd. Lipalytic action not reported.

100 Pseudomonas ananas.

101. Pseudomonas liquitri.

102 Pseudomonas sesami. 103 Pseudomonas tolaasu.

bbb Acid from sucrose not reported.

c Nitrates produced from nitrates

d. Motile.

101 Pseudomonas zanthochlora.

dd Non-motile. 105. Pseudomonas Thizocionia

cc. Nitrites not produced from nitrates

106 Pseudomonas barkeri 107. Pseudomonas aladioli.

108 Pseudomonas mellea

ecc Nitrite production not reported. 100 Pseudomonas betlis.

110 Pseudomonas panacis.

a. Gelatin not liquefied

b. Acid from sucrose c Nitrites produced from nitrates.

111. Pseudomonas aleuritidis,

ce Nitrites not produced from nitrates

112 Pseudomonas olucinea.

112a Pseudomonas alycinea var japonica. 113 Pseudomonas savastanov.

113a. Pseudomonas savastanoi var frazini.

114 Pseudomonas tonelliana

bb. No acid from sucrose e Nitrites not produced from nitrates.

115 Pseudomonas calendulae.

116 Pseudomonos richoria.

117 Pseudomonas cissicola. 118 Pseudomonas nectarophila

119 Pseudomonas viburni

bbb Acid from sucrose not reported

e Nitrites not produced from nitrates.

120. Pseudomonas mori.

121. Pseudomonas stitolohis. 122. Pseudomonas viciae.

2. Green fluorescent pigment not produced or not reported a Gelatin houefied.

b. Acid from sucrose.

genus Richettsoides da Rocha-Lima (loc. cit.).

6. Rickettsia akari Huebner, Jellison and Pomerantz. (Pub. Health Rept., 61, 1946, 1682.) From Acarus, a genus of mites.

Minute diplobacilli, occurring intracellularly and extracellularly, and bipolarly stained rods. Resemble typical rickettsiae morphologically. Non-motile.

Stain well by Machiavello's method, the organisms appearing bright red against a blue background. Stain poorly with methylene blue. Gram-negative. Occur intracytoplasmically and have been seen intranuclearly in yolk sac cells

Cultivation. In the volk sac of the chick embryo. No growth on artificial culture media.

Immunology. Guinea pigs recovered from rickettsialpox are immune to infection with strains isolated from infected mitne

Serology · Antigens prepared from infected yolk sacs are highly specific except for cross reactions with Rocky Mountain spotted fever antigens Sera from convalescent patients fixed complement with the homologous antigen and usually with Rocky Mountain spotted fever antigens though at a lower titer. Does not have a common antigenic factor with Proteus strains except that low titers were obtained in a few recovered cases in agglutination tests with Proteus OX19.

Pathogenicity: Pathogenic for man with focal initial erythematous lesion and adenopathy, followed by fever and appearance of macular rash. No mortality. Experimental infections have been produced in white mice and guinea pirs by the inoculation of infected blood firregularly), and of infected liver and spleen suspensions, infected brain, infected lymph nodes, tunics washings of infected animals and by infected yolk sacs Symptoms in mice include inactivity, accelerated respiration, ruffled fur, with occasional deaths; in guines pigs, fever and marked scrotal reactions. Infected embryos are killed in 4 to 7 days. It has not been found pathogenic for monkeys, distinguishing it from . Rickettsia conorus. It is also probably more pathogenic for white mice than Rickellsia conorii.

Source. Blood of a human case of rickettsialnox in New York City.

Habitat: Blood of human cases and an ectonarasite of rodents, the mite (Allodermanyssus sanguineus Hirst). The etiological agent of human rickettsialpox.

### Genus II. Coxiella Philip.

(Subgenus Cozzella Philip, Amer. Jour Hyg., 57, 1943, 306, Coziella Philip, Pub Health Repts , U S P. H S , 63, Jan. 9, 1948, 58, not Bengtson, gen. nor. as stated in first printing Manual, 6th ed , Jan 26, 1948, 1092)

Small, pleomorphie, rod-shaped and coccoid organisms, occurring intracellularly in the cytoplasm and extracellularly in infected ticks. Stain lightly with aniline dyes Gram-negative They are filterable. Have not been cultivated in cell-free media. Parasites of man and animals which include the etiological agent of Q fever. The type species is Coxiella burnetti (Derrick) Bengtson

1 Coxiella burnetii (Derrick) Bengtson comb nov (Rickettsia burneti Derrick, Med Jour Australia, 1, 1939, 14; Rickettsia diaporica Cox, Pub. Health Rep., 54, 1939, 1826. Rickettsia burneti

var. americana, Anon , Brit. Med. Jour., 2, 1941, 588; Rickettsia (Coxiella) burnett Philip, Amer. Jour. Hyg , 57, 1943, 306.) Named for F. M. Burnet who discovered the organism in Australia

microns. Non-motile Colored purplish with the Giemsa stain, and red against a blue background with the Machiavello stain. Stains well with azur III and methylene blue. Gram-negative

Cultivation: In plasma tissue culture of mammalian cells; on the chorio-allantoic membrane and in the yolk sac of the chick embryo; in rabbit teetes and in the endothelial cells overlying. Descemet's membrane of the rabbit eye

Immunology: Immunity conferred by infection appears less complete than in typhus and Rocky Mountain spotted fover. Strains from several different areas have been found to cross immunite in guinea pigs, but the true relationship of the disease occurring in different localities remains to be determined. Reciprocal cross-immunity between mite strains and human atrains has been demonstrated in rabbits, hamsters and mice

Serology Antigens from different strains vary in sensitivity when tested by complement fixation with immune sera. There are probably a number of different types on the basis of complement fixation with immune sera. Has a common antigenic factor with Proteus OV.K.

Resistance to chemical and physical accessive Readily inactivated by heat and chemical agents. Destroyed by a temperature of 50°C for 10 minutes, and by 0.1 per cent formalin and 0.5 per cent phenol.

Pathogenicity: Tathogenic for man, monkeys, gibbons, guines pogs, tamaters, rats, voles, mice, gerbulles, rabbuts (by introocular injection) and chick embryo. There is wide variation in the virulence of different strains for laboratory annuals, infection being established with great difficulty with some, while others may cause a high mortality.

A febrile reaction occurs in guinea pigs. Passage in guinea pigs and mice is accomplished by inoculation of infected spleen or blood from an infected animal, passage in rabbits by intraocular inoculation of blood, lymph node or organ emulsions of infected animals Ascites, enlarged spleen often with a fibrinous deposit are characteristic.

In man an eschar with adenopathy develops at the site of the mite bite. In scrub typhus the eschar is not present. A febrile reaction with exanthema occurs and mortality is variable.

In rabbits infection of Descemet's membrane follows intraocular injection of infected material.

Source. Seen by Hayashi in smears and sections of the lesion (seekar) at the site of the mite bite and in smears and sections of the adjacent lymph nodes from cases of the disease; also seen by Nagayo et al. (loe cit) in the endothelial cells overlying Descemet's membrane in rabbits inoculated intraocularly with infectious material.

Habitat. The mites (Trombicula alamush. Trombicula deltensis syn. T. walch., Trombicula feltcheri and probably several others). Infective through the owa of the adult female. Only the larvae feed on rodents or man. Reservoir hosts are probably certain wild rodents, including house and field rats, mice and voles and probably some birds. The etiological agent of tsutsugmushi disease and scrub typhus (for numerous other designations of the disease see Tarner and Katsampes, U. S. Naval Med. Bull., 43. 1911, 800.

Nore Rickettian imponica Sellarda. (Selfarda, Amer. Jour. Trop. Med., 5, 1923, 515., Rickettsiolder imponica da Rocha-Lina, in Kolle and Wasserman, Handb. d. path. Mikroorganismen, 3 Aufl., 8, 1930, 1320.) This problematical organism was thought by its author to be the cause of tsutsugamustid incase. Because it was cultivatible by the methods used by Selfarda, it is not now regarded as adentical with Rickettia Instructurants of Octable Rickettia Instructurants of California Selfarda, proposed as the type species (monotypy) of the

# Genus III. Cowdria Bengtson, gen. nov.

Named for E. V. Cowdry who first described the organism in heartwater of three ruminants, sheep, goats and cattle.

Small pleomorphic, spherical or ellipsoidal, occasionally rod-shaped organisms, occurring intracellularly in ticks Gram-negative. Have not been cultivated in cell-free media. Parasites which are the etiological agent of heartwater of cattle, sheep and goats.

The type species is Cowdria ruminantium (Cowdry) Bengtson.

 Cowdria ruminantium (Cowdry) Bengtson, comb. nov. (Rickettsa ruminantium Cowdry, Jour Exp. Med., 42, 1925, 231; Rickettsia (Cowdria) ruminantium Moshkovsky, Uspekhi Souremennoi Biologii (Russan) (Advances in Modern Biology), 19, 1915, 18.) From M. L. Ruminantia, the eud-chewing mammals

Differ morphologically from typical rickettsiae, showing usually spherical and ellipsoudal forms, occasionally bacillary forms. Irregular pleomorphic forms occur. Grow in the cytoplasm of cells, sometimes in densely packed masses. Size of cocci from 0.2 to 0.5 micron in diameter in the endothelial cells of animals, 0.2 to 0.3 micron in diameter in ticks. Bacillary forms 0.2 to 0.3 by 0.4 to 0.5 micron and pairs 0.2 by 0.8 micron in ticks. Non-motile.

Stain blue with the Giemsa stain and can also be stained by methylene blue and other basic anilme dyes. Gramnerative.

Cultivation not reported.

Immunology. Immunity incomplete after recovery from the infection. The organisms are found in the tissues long after recovery. There is some evidence of a variety of strains.

Pathogenicity Pathogenic for goats, sheep and cattle. Transmissible to goats by inoculation of infected blood intrajugularly. The most characteristic lesion is the hydropericardium of infected animals. The only small animal shown to be susceptible is the ferret

Source: Seen in the endothelial cells of renal glomeruli and in the endothelial cells of the cerebral cortex of animals suffering from heartwater and in the tick, Ambluomma hebraeum.

Habitat: The bont tick (Amblyomma hebraeum) and also Amblyomma carrieratum. When the tick is infected in the larval state, it can transmit the infection to the nymphal and adult stages, but the disease is not transmissible through the ova of the adult female tick. The ctiological agent of heartwater in sheep, goats and cattle in South Africa.

Appendix I: Further studies of the organism of trench fever are required before the relationship of Riclettisi quintana to the other more firmly established species of rickettsiae can be determined. Therefore, it is placed in this appendix.

 Rickettsia guintana Schminke. (Schminke, Münch. med. Wehnschr., 84, July 17, 1917, 951; Rickettsia wolhynica Jungmann and Kuczynski, Zischr. Min. Med., 85, 1918, 261; Fossilia guintana suggested as a possible subspecies "if necessary" by Megaw, Trop. Dis. Bull , 49, 1913, 825.

Probable synonym: Rickettsia pedicult Munk and da Rocha-Lima, Münch. med Wehnschr., 64, 1917, 1423.

Coccoid or elipsoidal organisms, alten occurring in pairs, more plump and staining more deeply with the Giema stain than Rickettsia prowarekti. Da Rocha-Lima gives their size as 02 to 0.4 micron by 0.3 to 0.5 micron. In lice appear as short rods, frequently in pairs and often bipolarly stained Non-motific.

Stain reddish-violet with the Giemss stain. Gram-negative. Occur extra-

Small bacterium-like, pleomorphic organisms varying in size from coccoid forms to well marked rods. Occur as cytoplasmic micro-colonies with diffuse or compact distribution of the organisms through the cytoplesm. Also seen extracellularly, where they appear as small lanceolate rods, diplobacilli and occasionally segmented filamentous forms Chains of 3 to 6 elements often seen Quite uniform in size and morphology in infected volk sacs and in mouse spleen with exceedingly minute forms in heavily infected material. Small lanceolate rods. 0 25 by 0 4 to 0.5 micron, bipolar forms 0 25 by 1.0 mieron, diplobacilli 0 25 by 1.5 microns. Non-motile

With Giemsa's stain they appear reddish-purple, with Machiavello's stain bright red against a blue background Gram-negative

Cultivation: May be cultivated in plasma tissue cultures, in modified Maitland media and in the yolk sac of chick embryos

Immunology: There is complete cross immunity between Australian and American strains of Q fever in guinea pigs Strains from other parts of the world also cross immunite.

Scrology American and Australian strains are identical by agglutination and agglutinin absorption Strains from various countries are serologically related as shown by complement fixation Q fever is distinguishable from other ruckettsial diseases by complement fixation tests. No common antigenic factor with any Proteus strain has been demonstrated

Filterability The infectious agent of Q fever readily passes Berkefeld N filters which are impermeable to ordinary bacteria and W filters which are impermeable to typhus and spotted fever rickettiane

Resistance to chemical and physical agents Comparatively resistant to heat, drying and chemical agents. Survives at least 100 days in cell free media with out loss of titer, resistant to 60°C for 1 hour and to 0.5 per cent formalm and 1 per cent phenol when tested in fertile eggs

Pathogenicity Pathogenic for man, guinea pig and the white mouse. The monkey, dog, white rat and rabbit are middly susceptible. Certain bush animals in Australia, particularly the landicoot, are susceptible and these animals have been found naturally infected. Other rodents and marsupials are mildly susceptible. Calves have been experimentally infected and coss have been found recovered from naturally acquired infections.

A febrile reaction occurs in guinea pigs but mortality is low except with heavily infected yolk see which causes a high mortality. On subcutaneous or intra-dermal inoculation a marked inflammatory thickening of the skin occurs at the site of inoculation On autopsy the site of inoculation On autopsy the spleen is enlarged from 2 to 12 times by weight and is engorged with blood Transfer in guinea pigs and mice is accomplished by transfer of infected liver and spleen. A febrile reaction often accompanied by pneumonitis occurs in man, but mortality is low.

Source First seen in smears from mice moculated intraperitoneally with infectious material by Burnet and Freeman (Med Jour Australia, 2, 1937 (2), 231).

(Med Jour Australia, 2, 1937 (2), 251). Habitat The wood tick, (Dermacnior anderson) and the ticks, Dermacnior occidentalis, Amblyonna americanum, Haemaphysalis leporis-palustris, Irodes deniates and Haemaphysalis humerous. Several other species of ticks have been shown to transmit experimentally the virus of Q fever. It has been found to survive in the one of the female ticks (Dermacnior andersons and Haemaphysalis humerosa). The landscoot (Isolom macrurus) is probably the natural reservoir of the disease in Australia. The etiological agent of Q (Queensland) fever in main.

rend. Soc. Biol., Paris, 126, 1937, 382; Ehrlichia canis Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18.) Moshkovsky selects this species as the type species of the subgenus Ehrlichia Moshkovsky (loc. cit.). Found in dogs used for experimental purposes in Algeria. Appears to be transmitted naturally by the dog tick (Rhipicephalus sanguineus) All active stages of the tick transmit the organism and it passes intraovarially from the female to the larvae of the next generation. The organisms are generally spherical in shape and can be seen in the circulating monocytes. The infection causes a serious and often fatal illness in dogs. Small laboratory animals are not susceptible to the disease.

Rickettsia conjunctivae, Rickettsia conjunctivae bovis and Rickettsia conjunctivae galli, see Family III, Chlamydozoaceae.

Richettsia etenocephali Sikora. (Arch. Schiffs- u. Tropenbyg., 22, 1918, 442) Found in eat fleas (presumably Classified Found in eat fleas (presumably Classified Found in the concephalides felis) on the surface of the organs in the body cavity and in the commic fluid. Two forms were found which might be two species, one resembling Richettsia pedieud: and the other Richettsia melophage. Hertig and Wolhach (Jour Med. Res. 44, 1921, 329) found Richettsia tenocephali to vary in size and shape from minute cocci to rather large, swollen, curved rods, stalining reddigh with the Giemss stalin.

Richeltsia eulies Brumpt. (Ann. Parasitol. Hum. et Comp., 16, 1938, 153.) Found in the stomach epithelium of mosquitoes (Culez fatiguns) 12 days after they had been fed on a patient carrying Microfilaria bancrofit. Thought to be pathogenic for the mosquito and possibly for man Occurs in the form of small granules and more often as small bipolar rods. Stains with haemalam, erythrosine-orange and toluidine blue. Gramnegative.

Rickettsia dermacentrophila Steinhaus. (Pub. Health Repts., 67, 1942, 1375) Found in all stages of the wood tick (Dermacentor andersoni). In the epithelial cells of the intestinal diverticula and other tissues of the tick, usually extracellularly but sometimes intracellularly. Not seen in the nuclei of cells. Gramnegative and staining red with the Machiavello stain, and bluish-purple with the Giemsa stain, Stains less deculy with ordinary bacterial stains than most bacteria. Resembles Rickettsia rickettsii morphologically but is slightly larger. Not pathogenic for laboratory animals or for some of the natural hosts of Dermacentor andersoni.

Rickettsia hirundinis Cowdry. Jour. Exp. Med., 57, 1923, 431.) An organism observed by Arkwright, Atkin and Baco' (Parasitology, 15, 1921, 27) in the tissues of Cimex hirundinis which is probably the same organism to which Cowdry referred as Rickettsia hirundinis. Considered by Steinhaus as a nomen nubum.

Rickettsia kairo da Rocha-Lima. (Cairo rickettsia, Arkwright and Bacot. Brit. Jour. Exper. Path., 4, 1923, 70; da Rocha-Lima, in Kolle and Wasserman, Handb. d. path. Mikroorg., 3 Aufl., 8, 1930, 1361.) Resembles Hickettsia rochalimae and Rickettsia promazekit.

Rickettsia lectularia Arkwright, Atkin and Bacot. (Parasitology, 13, 1921, 27.) Found in the gut of the bedbug (Cimez lectularius) as filamentous and rodshaped organisms. It seems probable that all bedbugs harbor the organism and it is also present in the developing ova. The location is intracellular. Very pleomorphic, ranging from small coccoid forms to thread-like forms. The small coccoid and diplococcoid forms stain deep purple with the Giemsa stain, while bacillary, lanceolate and thread forms stain more red than purple with the Giemsa stain. Not infective for small laboratory animals or for man.

Rickettsia linognathi Hindle. (Parasitology, 13, 1921, 152.) Found in the cellularly in the region of the epithelial lining of the gut of the louse.

Cultivation: Has not been cultivated in tissue culture or any cell-free medium, though Richettsia pediculi, considered by some identical with Richettsia guintana, has been cultivated on human and horse blood scar.

Pathogenicity. Pathogense for man, causing recurrent fever. No strain has been definitely established in laboratory animals.

Immunology · Partial immunity is produced after an attack of the discase. The disease is characterized by relapses which may occur as long as two years after the initial attack.

Distinctive characteristics: The organism resists a temperature of 60°C moist heat for 30 minutes or a dry heat at 80°C for 20 minutes. It reasts desic cation in sunlight for 4 months 1 t is filterable under certain conditions but not when in plasma or serum It is present in filtrates of infected vaccine sediments and everements of infected line.

Source: Seen in lice fed on trench fever patients by Topfer (Münch med Wehnschr., 61, 1916, 1495)

Habitat- The epithelial lunung of the gut of the body louse (Pediculus humanus var. corports) where they occur extracellularly, and Pediculus capitis The virus is not transmissible through the ova May be the ethological agent of trench fever (Wolhynian Iever, shin bone fever, five-day fever)

Appendix II: Additional named species are included in Chapter V, Relectistac, in Steinhaus, Insect Microbiology Ithaca, 1936, 304-328 Some differ morphologically and tinctorully from typical rickettance, some are not associated with an arthropod vector, some have been incompletely studied and described, some have been cultivated in cell-free media. Pending the completion of further studies involving possible

cultivation in fertile eggs, the determination of biological properties, and adequate comparative immunological and scrological studies, no attempt is made to classify these organisms. The descriptions are condensed from those given by Steinbaus:

Ekritichia (Rickettaia) kurloui Moshkoveky. (Compt. rend. Soc. Biol., Paris, 186, 1937, 379; Ekrlichia kurloui Moshkoveky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 12.) Found in the monocytes of guinea pigs. Described by Kurloff in 1859 as inclusions in the mononuclear cells of guinea pigs and other animals. These became known as Kurloff bodies. However, the parasitism of these bodies is questionable.

Richtisia arium Carpano. (Riv. Pat. Comp., Jan. Feb., 1936, 1.) Minute bodies in the leucocytes and tissue cells of a builfinch (Pyrrhale auropea) brought to Egypt from Germany. Donation and Lestoquard (Arch. Inst Pasteur Algéria, 18, 1937, 142) suggested that this organism might have been that of psittacesis.

Rickettsia boris Donation and Lestoquard. (Donation and Lestoquard, Bull. Soc Path Exet., 29, 1936, 1057; Ehrlichia bous Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18.) Concorned in a disease of cattle which is transmitted by an unidentified tick of the genus Hyalomma The organism occurs in circular or round angled polyconst masses which consist of a large number of tightly pressed, minute spherical granulations These masses are situated in the cytoplasm of various monocytes The organism causes a relatively light febrile disease in cattle, and an inapparent infection in slicer and fever in monkeys

Rickettsia canis Donation and Lestoquard. (Donation and Lestoquard, Bull. Soc Path Exot., \$8, 1935, 418; Ehrlichia (Rickettsia) canis Moshkovsky, Compt. rocha-limae. It causes a febrile illness in man in which relapses occurred 3 to 5 times as in trench fever. Richetista weigli was agglutinated by convalescent sora but not by sera from typhus patients. Convalescent sera gave no positive Weil-Felix reaction.

Wolbachta pipientis Hertig. (Rickettsia of Culex pipiens, Hertig and Wolbach, Jour. Med. Res., 44, 1921, 329; Hertig, Parasitology, 28, 1936, 453.) This is the type species of the genus Wolbachia Hertig (loc. cit ). Found in the ovaries or testes of the mosquito, and present in all stages o the mosquito's development. The outstanding morphological characteristic of the organism is great pleomorphism. Minute coccoids and short rods may be considered typical, but the usual microscopic field consists of various shapes and sizes. Some forms show bipolar staining with the Giemsa stain. The organism is a harmless parasite of the mosquito. Laboratory animals are apparently not susceptible.

The following unnamed rickettsuse isolated from animals or seen in animals are included in Steinhaus' list of rickettsuse (Insect Microbiology Ithaca, 1946, 344).

A rickettsia was isolated by Parker, Kohls, Cox and Davis (Pub Health Rept., 64, 1939, 1482) from a tick (Amblyomma maculatum). It is pathogenie for guinea pigs and the disease is referred to as the maculatum disease. There is complete cross immunity in guinea pigs between this infection and Rocky Mountain spotted fever and boutomeuse fever, but it differs from these diseases in some particulars.

A rickettsia-like organism was isolated from the reduviid bug (Triatomar utora-fasciata) by Webb (Parasitology, 52, 1910, 355) It was pathogeme for some laboratory animals and was maintained in gunea pigs for 5 passages The rickettsiae were transmissible to the

next generation through the egg of the reduvild bug.

A spotted fever type of rickettsin was isolated by Anigstein and Bader (Tensa Repts. Biol. Med., I, 1943, 105) from the dog tick (Rhipicephalus sanguineus), taken from normal dogs. It was pathegenic for rabbits and guinea pies

A rickettsia was isolated by Anigstein and Bader (Texas Repts. Biol. Med., t, 1913, 298, 389) from ticks (Amblyomma americanum) collected in Texas. They believed it to be the cause of builis fever

Rickettsiae were observed by Enigh (Berl. u. Munch. Tierarzti. Wchnschr., 1942, 25) in the leucocytes of a bison calf. No arthropod was associated with this rickettsia.

A rickettsia-like agent pathogenie for guinea pigs was reported by Tatlock (Proc. Soc. Exp Biol. and Med., 57, 1944, 95). The animals had been injected with blood from a patient with "pretibial" fever. No arthropod vector was indicated.

Three species of rickettsia-like organisms isolated from the wood-tick (Dermacentor andersont) are described by Noguchi (Jour. Exper. Med., 43, 1926, 518-521). These were named Bactllus rickettsiforms, Bacillus pseudo-zerosis and Bacillus equidistans. All could be cultivated on cell-free media and none was pathogenic for laboratory animals.

Appendix III: Unnamed rickettsialike organisms seen in the tissues of insects

Hertig and Wolbach (Jour. Med. Res., 44, 1924, 329) list sixteen species of arachnids and twenty-three species of insects which are hosts to rickettsiae or rickettsia-like organisms.

Wolbach (Jour. Amer. Med. Assoc., \$4, 1925, 723) reports hosts of non-pathogener ricketsiae which include fourteen species of arachulds (ticks, mites and spidors) and twenty-two species of insects distributed in nine orders, including

alimentary tract of the goat louse (Linognathus stenopsis). Resembles Rickettsia trichodectas morphologically and occurs only extracellularly in the lumen of the cut

Rickettssa melophani Nöller (Arch Schiffs- u Tropenhye . 21. 1917, 53 ) Found upon and in the cuticular laver covering the enithelium of the midintestine of the sheep tick (Melophagus ovinus). Occurs characteristically in pairs of fairly uniform size, coccord and sometimes md-shaped. Gram-negative but stains fairly well with carbol-fuchsin and gentian violet. Stains deep numle with Giemsa's method and bright red with Machiavello's method Has been cultivated on non-living culture media. a glucose-blood-bouillon agar medium The ability of Rickettsia melophagi to infect sheep has been the subject of contradictory claims. Small laboratory animals seem not to be suscentible

Richettera oring Lestoquard and Donatien. (Lestoquard and Donatien, Bull Soc. Path. Exot., 29, 1936, 108, Chrlichia oring Moshkovsky, Usphekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 18 ) Found in the blood of diseased sheep from Turkey and Algeria. The organisms occur as minute coccoid granules, grouped in masses and present only in the monocytes and never in endothelial cells They stain uniformly dark red with the Giemsa stain but did not stain with the Castafieda technic. Infected ticks (Rhs. picephalus bursa) are thought to be the vectors.

Rickettaia piece Mohamed (Munatry Agr. 7. Egypt., Tech. Sci. Serv. Bull. 24, 1939, 6 pp.) In the monocytes and plasma of the blood of a fish (Tetraodon Jahda) shoming necrotic ulcers on its head and both sides of the body. The heart, liver and intestines shoned if—sions The organisms were minute receival forms awaying from 0.2 to 0.4 nucron in dataneter and frequently occurring in rairr.

Rickettsia rocha-limae Weigl, (Przglad. Epidemi., 1, 1921, 375 ) Occurs in lice (Pediculus humanus) but is anparently non-nathogenic either to lice or to vertebrates. Larger and more pleamornhie than Rickelleig proposed is In smears or sections of the sut of lice Ricketisia tocha-limae occurs in agglomerated masses, grouned like stanbulgeone They occur both extracellularly and intracellularly and stain more deenly than Rickettsia propagelis Weigl claims to have cultivated this species on artificial culture media under anaerobic conditions. Not nathogenic for laborators animals or man

Rickettsia sus Donatien and Gayot. (Bull Soc. Path. Irot , 37, 1912, 324) Causes a disease in as ine, the pathology of which resembles heartwater of ruminants See Genus III, Cowdria, Family Rickettsiaccoe

Ribélitus trubolectae Hindle. (Parsattology, 18, 1921, 192). In the species of biting line (Trubolectas pilosus) which may be found on horses. This insect does not suck blood. The organisms occur extracellularly in the alimentary tract of the louse. The average size is 0 3 to 0 5 by 0 5 to 0 9 micron and occasionally longer forms occur.

Rickettera werdt Mosing (Arch Inst. Pasteur, Tunis, 25, 1936, 373 ) Concerned in an emilenic disease which broke out in 1931 among employees of the Institute of Biology in Luón abo were engaged in feeding supposedly uninfected fice on their persons. Mosing and others have suggested the possibility that this rickettsia may be an extreme mutant of Rickettsia pediculi, Small coccord to rod shaped organisms staining well with the Gierra stain, usually slightly longer than Ricketting progra-In the longe (Pediculus humanua), the ricketteiae occur extracellutarly in the intestinal lumen forming a layer covering the surface of the enithelial lining Not pathogenic for the lause ne is Rickettera prograzekii and Rickettera

# FAMILY II. BARTONELLACEAE GIESZCZYKIEWICZ.\*

(Bull. Intern. Acad. Polon. Sci, Classe Sci. Math. Nat., B (I), 1939, 9-30.)\*\*
Small, often pleomorphic, rod-shaped, coccoid, ring-shaped, filamentous and beaded micro-organisms, staining lightly with aniline dyes, but well with Giemss's stain. Gram-negative. Parasites of the crythocytes in man and other vertebrates Known to be transmitted by arthropod vectors in some cases. The causative organisms of bartonellosis in man, haemobartonellosis, grahamellosis and eperythrozonosis in the lower animals. Differ from the protozoa that also parasitize crythrozytes in that the entire parasite stains with no differentiation into cytoplasm and nucleus.

## Key to the genera of family Bartonellaceae.

- 1. Parasites of the erythrocytes and of fixed tissue in man.
- Genus I. Bartonella, p. 1100
   Parasites of the erythrocytes of lower mammals, increased in susceptible animals by splenectomy. Eradicated by arsenicals.

Genus II. Haemobartonella, p. 1102

3. Parasites of the erythrocytes of lower mammals. Not increased in susceptible

 rarasites of the erythrocytes of lower mammals. Not increased in susceptible animals by splenectomy. Not eradicated by arsenicals. Genus III. Grahamella, p. 1109.

 Blood parasites, found on the erythrocytes and in the plasma of lower manuals. Appear as rings, ecceoids and short rods. Splenectomy activates platent infections. Genus IV. Eperythrozoon, p 1111.

## Genus I. Bartonella Strong, Tyzzer and Sellards.

(Bartonia Strong, Tyzzer, Brues, Sellards and Gastiaburú, Jour. Amer Med Assoc., 61, 1913, 1715, not Bartonia Mublenberg, in Willdenow, Neue Schrift Ge Nat. Fr., Berlin, 3, 1801, 444; not Bartonia Sims, Bot. Mag., 1804, not Bartonia Crossman, Essais de Paleoconchologie Comparée, 4me Livr., Paris, 1901; Strong, Tyzzer and Sellards, Jour. Amer. Med. Assoc., 64, 1915, 808; emend. Tyzzer and Weinman, Amer. Jour. Hyg., 30 B, 1939, 143) Named for A. L. Barton who described these organisms in 1909.

Parastes of the crythrocytes which also multiply in fixed tissue cells. On the red blood cells in stained films, they appear as rounded or oval forms or as slender, straight, curved or bent rods occurring either singly or in groups. Characteristically in chains of several segmenting organisms, sometimes swollen at one or both ends and

\* Prepared by Dr. Ida A. Bengtson (retired), National Institute of Health, Bethesda, Maryland and Dr. David Weinman, Parasitologist to the 1937 Harvard Expedition to Peru, Boston, Mass., April, 1947.

\*\* Partial syn. Anaplasmidae has been proposed as a lamily name to unite the four genera Anaplasma, Grahamella, Bartonella and Eperythrozon by Neitz, Alexander and du Toit (Onderst Jour. Vet. Sci. and An. Ind. 5, 1931, 289). Since the name is derived from Anaplasma, the nature of which is not fully understood and since these authors consider the 4 genera as belonging to the protozon order Haemosprida, it seems advisable not to consider this nomenclature for the present. The genus Anaplasma (parasites of the red blood cells of cattle) created by Theiler (Transval Giort. Vet. Bact. Ropt. 1908-9, 7-64, 1910) consists of two species Anaplasma marginale and Anaplasma centrale. Recent workers are inclined to consider them to be bacternal in nature as they do not show a differentiation into cytoplasm and nucleus.

numerous non-blood-sucking insects as well as lice and ticks.

Cowdry (Arch Path and Lab Med, 2, 1926, 59) lists seven species of arachnids and twenty-four species of insects which are hosts to non-pathogenic rick-ettisiae.

Buchner, P. (Tier und Pflanze in Symbiose. Gebrüder Borntraeger, Berlin, 1939, 900 pp) Through the text, and particularly on pages 300-664, the rickettsia-like and bacterium-like nucroorganisms occurring intracellularly in insects and other small animals are discussed, principally from the viewpoint of the biologist

the biologist
Paillot, \( \) (L'infection chez les Insects, Paris, 1933, 525 pp) Concerned
principally with bacterial infections of
insects, but also includes information in
mitracellular symbiotes and rickettsalike and bacterium-like microorganisms.
Steinhaus, Edward \( \). (Insect microbiology Ithaca, 1916, 188-255) Intracellular bacterium-like and rickettsalike symbiotes are discussed.

- c. Nitrites produced from nitrates.
  - d. Beef-peptone agar turns dark brown.
    - Pseudomonas alliicola.
  - 124. Pseudomonas gardeniae.
  - dd. Beef-peptone agar remains uncolored or light discoloration after several weeks.
    - e. Colonies tan to brown.
      - 125. Pseudomonas caryophylli.
      - 126. Pseudomonas solanaccarum.
      - 126a. Pseudomonas solanaccarum var. asia-
    - ce. Colonies white or colorless,
      - 127. Pseudomonas castaneae.
      - 128. Pseudomonas castaneae.
- cc. Nitrites not produced from nitrates.
- 129. Pseudomonas passifloriae.
- bb. No acid from sucrose. 130. Pseudomonas fabae.
- bbb. Acid from sucrose not reported.
  - c. Nitrites not produced from nitrates.
    - 131. Pseudomonas astragali.
    - 132. Pseudomonas colurnac.
    - 133. Pseudomonas maublancii.
    - 134. Pseudomonas polygoni.
    - cc Nitrate production not reported.
      - 135. Pseudomonas iridicola.
      - 136. Pseudomonas levistici.
      - 137. Pseudomonas radiciperda.
- aa. Gelatin not liquefied.
  - h. Acid from sucrose.
    - c. Nitrites not produced from nitrates.
    - 138. Pseudomonas melaphthora.
    - cc. Gas from nitrates.
      - 139. Pseudomonas helianthi,
  - bb. No acid from sucrose.
    - c. Nitrites produced from nitrates.
      - 140. Pseudomonas alboprecipitans.
      - 141. Pseudomonas vetasitis.
      - 142. Pseudomonas lignicola,
    - cc. Nitrites not produced from nitrates.
      - 143. Pseudomonas andropogoni.
  - 144. Pseudomonas woodsii.
  - bbb. Acid from sucrose not reported.
    c. Nitrites produced from nitrates.
    - 145. Pseudomonas vanici-miliacei.
      - 146. Pseudomonas saliciperda.
    - cc. Nitrites not produced from nitrates.
    - Pseudomonas eriobotryae.
- uaa. Gelatin liquefaction not reported.

  b Nitrites not produced from nitrates.
  - 148. Pseudomonas wieringae.

frequently beaded (Strong et al., loc. cit., 1913), without a distinct differentiation of nucleus and cytoplasm. In the ussues they are situated within the cytoplasm of endothelial cells as isolated elements and grouped in rounded masses. These parasites occur spontaneously in man and in arthroped vectors, are endowed with independent motility, reproduce by binary fission, and may be cultivated by unlimited scrial transfers on cell-free media. One species has been recognized. It is known to be established only on the South American continent and perhaps in Central America. Human bartonellosis may be manifested clinically by one of the two syndromes constituting Carrión's disease (Oroya fever or vertuga perunas) or as an asymptomatic infection (definition by Strong, Tyzzer and Sellards emend. Tyzzer and Weinman (in Weinman, Trans. Amer Philosoph Soc, N.S., 33, pt. 3, 1944, 216).

The type species is Bartonella bacelleformes (Strong et al.) Strong et al.

1. Bartonella bacilliformis (Strong. Tyzzer, Brues, Sellards and Gastiaburú) Strong, Tyzzer and Sellards (Bartonia bacilliformis Strong et al . Jour Amer Med Assoc , 61, 1913, 1715; Bartonella bacilliformis Strong, Tyzzer and Sellards, Jour Amer. Med. Assoc . 64, 1915, 808, emend Tyzzer and Weinman, Amer. Jour Hyg 30(B), 1939, 143, also see Weinman, Trans Amer, Philosoph Soc, N.S. 33, pt 3, 1914, 246 Partial or complete synonyms Bartonella cocorde (sic) Hercelles, Ann de Pae de Med , Lima, 9. 1926. 231. Bartonella peruviana Escomel, Bull Soc path Evot , 22, 1929, 351, Enerthyrozoon noguehu Lwoff and Vaucel, Compt rend Soc. Biol , Paris, 103, 1930, 975.) From Latin bacillus, rod and forma, shape.

Small, pleomorphic organisms, showing greatest morphological range in the blood of man, appearing as red-violet rods or coccoids situated on the red cells, when stained with Giemsa's stain. Bacilliform bodies are the most typical. measuring 0.25 to 0.5 by 1 to 3 microns Often curved and may show polar en largement and granules at one or both ends Rounded organisms about 0.75 micron in diameter and a ringlike variety is sometimes abundant. On semi-solid media a mixture of tuds and granules appear. The organisms may occur singly or in large and small, ifregular dense collections, measuring up to 25 microns or more in length Punctiform, spindle-shaped and ellipsoial forms of the organism occur, varying in size from 0.2 to 0.5 by 0.3 to 3 microns.

Gram-negative and non-acid-fast. Stain poorly or not at all with the usual aniline dye stains, but satisfactorily with Romanowsky and Giemsa stains

Motile in the blood and in cultures.

One to four unipolar flacella.

Cultivation Growth in semi-solid agar with themselved and rabbit hemoglobin and in semi-solid agar with blood of man, horse or rabbit with or without the addition of fresh tissue and certain carbohydrates, in other culture media containing blood, serum or plasma, Huntoon's hormone agar at 20 per cent, semi-solid gelatu media, blood-glucoseystine agar, chorn-allantoic fluid and yolk sac of chick embryo

Gelatin not liquefied

No acid or gas n glucose, sucrose, galactose, maltose, fructose, xylose, lactose, mannose, mannitol, dulcitol, arabinose, raffinose, rhamnose, devtrin, inulin, salicin and annycialin

No action on lead acctate.

Aerobic, obligate

Optimum temperature 28°C.

Immunology Natural immunity to infection has not been demonstrated in susceptible species. Acquired immunity apparent both during and after the disease. Buttonells from different sources appear to provoke similar responses. Bartonellse from Oroya fever protect

against infection with organisms obtained from verruga cases.

Serology: Immune sera fix complement and agglutination of suspensions of Bartonella by sera from recovered cases has been reported.

Pathogenicity: Three forms of the disease occur in man; the anemic (Oroya fever), the eruptive (verruga peruana) and mixed types of both of the other forms Experimental Oroya fever has not been successfully produced in animals, except rarely in an atypical form in monkeys. Experimental verruga pertiana has been produced in man, in a number of species of monkeys and occasionally in does.

Source: Blood and endothelial cells of lymph glands, spicen and liver of human cases of Oroya fever.

Habitat: Blood and endothelial cells of infected man, probably also in sand flies (Phlebotomus verrucarum and Phlebolomus noguchis).

## Genus II. Haemobartonella Tuzzer and Weinman,

(Amer. Jour. Hyg., 50(B), 1939, 141.) From Greek haemos, blood and the generic name Bartonella.

Includes parasites of the red blood cells in which there is no demonstrable multiplication in the tissues and which do not produce cutaneous eruptions. They are typically rod- or coccoid-shaped, showing no differentiation into nucleus and cytoplasm, occurring naturally as parasites of vertebrates, and are transmitted by arthropods. They are distributed over the surface of the crythrocytes, and possibly sometimes within them. They stain well with Romanowsky type stains and poorly with other aniline dyes. Gram-negative. Not cultivated indefinitely in cell-free material. Rarely produce disease in animals without splenectomy, are markedly influenced by arsenotherapy, and are almost all of world-wide distribution. The experimental host range is restricted, infectivity of a rodent species for other rodents being common, but for primates unknown.

The type species is Haemobartonella muris (Mayer) Tyzzer and Weinman.

## Key to the species of genus Haemobartonella.

- I The etiological agent of haemobartonellosis of the white rat. 1. Haemobartonella muris.
- II. The etiological agent of haemobartonellosis of the dog.
  - 2. Haemobarlonella canis.
- III. The etiological agent of haemobartonellosis of the vole.
  - 3. Haemobartonella microtii.
- IV. The etiological agent of haemobartonellosis of the guinea pig. 4. Haemobartonella tyzzeri.
- V. The etiological agent of haemobartonellosis of cattle.
- 5. Haemobartonella bovis.
- VI. The etiological agent of haemobartonellosis of the buffalo. 6. Haemobartonella sturmanii.
- VII. The etiological agent of haemobartonellosis of the deer mouse. 7. Haemobartonella peromyscii.
- VIII. The etiological agent of haemobartonellosis of the gray-backed deer mouse. 7a. Haemobartonella peromyscii car.
  - maniculati. IX. The etiological agent of haemobartonellosis of the short-tailed shrew.
    - 8. Haemobartonella blarinae.
  - X. The etiological agent of haemobartonellosis of the gray squirrel. 9. Haemobarionella sciuris.

1. Haemobartonella muris (Mayer) Tyzzer and Weinman. (Bartonella muris Mayor, Arch. f. Schiffs- u. Tropen-hyg., 28, 1921, 151; Bartonella muris ratti Regendanz and Kikuth, Compt rend Soc. Biol, Paris, 28, 1928, 1578; Tyzzer and Weinman, Amer. Jour. Hyg., 50(B), 1939, 143.) From Iatin mus, muris, mouse.

Siender rods with rounded ends, frequently showing granules or swellings at one or both extremities, and dumbbell, coccoid or diplococcoid forms May occur individually, in pairs, or in short chams of 3 or 4 elements, and, when abundant, in parallel grouping. The rods measure 01 by 07 to 1.3 merons and as much as half the leight of a red cell. The coccoids have a diameter of 01 to 02 micron

They have been found on and in the erythrocytes and in the plasma Preferred stains are those of the Romanowsky type. With Giomza's stain various investigators report an intense red coloration, a bluish tinge with distinct pink shading, blue with purple granules. With Wright's stain, the organisms stain bluish, with reddish granules at the ends With Schilling's methylene blue-cosin stain the organisms stain a bright red color with the cryther staining blue. They stain faintly with Manson's stain, pronin-methyl.

green and fuch-in. Gram-negative
There is luck of agreement concerning
visibility in the fresh state and motility
Various authors report Brownian movement, slow and sinuous motion in the
red cell or rapid motion.

Cultivation: Cultivated with difficulty and divergent results has been reported. Growth on various media reported (blood agar, agr. with 2 per cent defibrinated rat blood, horse blood agar, N. N. N. Y. with blood of rabbit, horse or man, ascite fluid agar, checolate agar, semi-solid rabbit and the semi-solid rabbit between agar, semi-solid rabbit blood agar, Noguchi-Wenpon meduum, defibrinated rat blood, glucoso broth,

Tarozzi broth, pephone water) but usually growth was seant or could not be continued by transfer to the same medium or the organism isolated was noninfectious or the possibility of latent infections in the animal was not evoluded. Best results are apparently obtained with sems-sold rabbit serum agar and semisold rabbit blood agar.

No conclusive results have been reported in tissue culture. The organism has been cultivated on the chorio-allantoic membrane of the chick embryo.

Filterability Non-filterable with Scitz or Berkefeld N filters.

Immunology: No authentic case of true natural immunity in rats has been established. Acquired immunity occurs in (1) the latently-infected rat, (2) the infected rat after splenectomy and recovery from the disease, the period of resistance corresponding to the duration of latency, (3) the non-splenectomized non-carrier rat following infection, (4) animals other than the rat following infection.

Serology. No precipitins, thrombocytobarm, isoagglutinins, or cold hemolysias have been reported in the serum of anemic mats. Complement deviation and agglutination have been reported with sera from rabbits, rats and guinea pigs injected with cultures. Rabbits immunized with cultures have given positive Well-Pelix reactions with Proteus OX19 and OXK and rat sera recovered from haemobartonellosis have given a positive Well-Pelix reaction and positive agglutination in low dilution with Rickettray protragets.

Pathogenicity: Infected blood, liver suspension, defibrinated laked blood, washed red cells, plasma and hemoglo-bunrie urine may produce infection by the subeutaneous, intra-cous, intra-perioncal or intracardiac routes. Slight, transient or no haemolartonellosis occurs in adult non-splencetomired haemo-lartonella-free albino rats, adult non-splencetomired arbitrations, adult splencetomired rats prestock, adult splencetomired rats pre-

viously infected, until 15 weeks to 8 months after infection. Typical haemobartonellosis occurs in adult splenectomized haemobartonella-free albino rate and in young non-splenectomized haemobartonella-free albino rats weighing 20 to 30 grams at 3 weeks. Variable results have been obtained by different investigators with wild mice, guinea pigs, rabbits, hamsters, pigeons and monkeys (Macacus rhesus and Macacus sp ). It is known to be infectious for wild rats, albino mice, rabbits and for two Palestinian rodents (Sphallax (Spalax correct designation) typhlops and Meriones tristramí). Negative results have been reported in dogs, kittens, cats, sheep and various birds. Causes a definite and characteristic anemia without cutaneous eruption.

Arsenical therapy: True sterilization of latent or recognized infection with organic arsenical compounds.

Source: Blood of infected albino rats. Habitat: Ectoparasites such as the rat louse (Polyplaz (Haematopinus) spinulosus), the flea (Xenopsylla cheopis) and possibly the bedbug (Cheopis) and possibly the bedbug (Cheopis) also found in the crythrocytes of susceptible animals. World wide in distribution.

 Haemobartonella canis (Kikuth) Tyzzer and Weinman. (Bartonella canis Kikuth, Khn. Wehnschr., 1928, 1720; Tyzzer and Weinman, Amer. Jour. Hyg., 30(B), 1939, 151.) From Latin canis, dog.

One of the most pleomorphic of the haemobartonellae, occurring as thin rods, straight or slightly curved, dumbbell-shaped organisms, dots, coccoids, or rings. Chains of rods, coccoids or rings coccur. These consist of only one type of these forms or a mixture of types. The chains may be straight, curved, branched or annular. Variable in size Round forms vary from 0.2 or 0.5 micron to the limit of yisibility. Single rods are 0.2 by 1 to 5 microns, while the

composite forms vary from 1 to 4 microns. Situation is epi-erythrocytic.

Giemsa's fluid stains the organism red-violet, usually intensely. Methylene blue used as a vital stain colors the organism distinctly. Gram-negative and non-acid-fast,

Considered non-motile by most investigators.

Cultivation · Cultivation has not been demonstrated in semi-solid rabbit serumagar medium nor in media containing serum of splenectomized dogs, N.N.N., Noguchi's medium for leptospira, blood broth, Chatton's medium covered with vasching for Trichomatics.

Filterability: Results equivocal.

Immunology: The outstanding phenomena resemble those found in the rat infected with Haemobartonella murss

Pathogenicity: Splenectomy is essential to infection accompanied by anoma in the dog. Negative results in splenectomized haemobartonella-free guines pig, rat, rabbit, and monkey (Cercopitheus sabeaus). No infection or anemia in unoperated mice, white rats, young rabbits, young dogs and young guines pigs. The splenectomized cat has been found to carry the infection by serial passage.

Arsenical therapy: Complete sterilization obtained by neoarsphenamine.

Source: Erythrocytes of infected spienectomized dogs.

Habitat: Found in dog fleas (Cieno-cephalus) and crythocytes of infected animals. Distribution wide-spread, the infection occurring spontaneously in Europe, India, North and South Africa, North and South America.

3. Haemobartonella microtii Tyzer and Weinman. (Tyzer and Weinman, Amer. Jour. Ilyg., 30(B), 1939, 143, also see Weinman, Trans. Amer Philosoph. Soc., N. S., 55, 1944, 312; questionable synonym Bartonella arvicolae Yakimoff, Arch. Inst Past de Tunia, 17, 1923, 533; Haemobartonella arvicolae Weinman, loc.

cit, 290) From the genus of voles,

In infected animal, morphology resembles that of Haemobartonella cants. the organisms occurring as rods, coccoids, filaments, club forms, ring forms and granular masses In addition to these forms there occur in Giemsa-stained blood films avoids, diamond- or flameshaped small forms as well as coarse segmented or unsegmented filaments up to 5 microns in length Filaments may contain one or more rings, or may be composed in part or entirely of diamondshaped, coccoid or ovoid elements, sometimes in parallel rows Rods often show intense bipolar staining. Coccoid forms. usually scattered, may occur as aggregates or clumps on the red cell, apparently embedded in a faint blue matrix

A pale blue veil-like substance may cover nearly half of one surface of the red cells and show at its border typical red-violet stained rods or filaments in the Giemsa-stanged specimens A boxshaped arrangement of elements is characteristic Organisms lie on the surface of the red cells. In cultures organisms are more uniform in morphology resembling Bartonella bacıllıformıs Individual organisms are fine rods, 03 by 10 to 2 microns, sometimes occurring in chains and often in clumps Small round forms occur, measuring 0.5 micron in diameter, and occasionally round disk-like structures

Cultivation, Growth in Noguchi's seemi-sold securin agar 2 weeks after traoculation with citrated or heparanzed blood and incubated at 23°C shows as white rounded masses, measuring up to about 1 mm in the upper 15 mm of the tube. In tissue culture the organism grows in small, rounded compact masses within the cytoplasm of infected cells Indefinite maintenance of the strains isolated on artificial media has not been possible.

Pathogenicity Splenoctomized white mice and splenoctomized Interactory reared voles are readily susceptible to infection. No marked anemia or any mortality in heavily infected animals. Splenectomized dogs, white rats and deer nice are not susceptible.

Source and habitat Erythrocytes of the vole (Microtus pennsyliannus pennsyliannus) following splenectomy The natural mode of transmission has not been determined though ticks or mites are suspected

4 Haemobartonella tyzzeri (Weiman and Pinkerton) Weimana. (Bartonella tyzzeri Weimana and Pinkerton, Ann Trop Med, 32, 1938, 217; Weimana, Trans Amer Philosoph. Soc. 33, 1914, 314) Named for Prof Tyzzer who studied baemobartonellae

Single or composite rods from about 0.25 micron b) 1.4 to 4.0 microns. Occasional granular swellings and enlarged poles. Short rods also occur averiging 0.2 to 0.3 by 0.8 micron and also round forms with diameters of 0.2 to 0.3 micron. Distributed irregularly in the red cells.

Stain intensely red-violet with Giemsa's or May-Grunnald-Giemsa's solutions Gram-negative.

Cultivation Initial cultures on Negucitis genus-solid serum agar obtained itregularly. When incubated at 28°C, colonies appear as isolated white spheres about 1 mm in diameter in the upper 8 mm border of the medium. The clumps are composed of rods and granules, with larger round structures or disks occurring occasionally. Also culturated on the Zimszer, Wei and Pitzpatrick modification of the Mattland medium. Prolonged maintenance on semi-solid media has not been obtained.

Pathogenetify Spleneetomized Laemobertonella free guinea pigs may be infected by blood or cultures injected aubeutaneously or intraperitoneally. Spleneetomized Haemobatonila runsifree rats are insusceptible when inoculated with infected guineapig blood Vacaciar rheave monkeys are also insusceptible to inoculations of infected blood, tissue and cultures. Infection of the guinea pig is subclinical in its manifestations, probably due to the small number of parasites in the blood. No definite anemia accompanies infection.

Source and habitat: Erythrocytes of the Peruvian guince pig (Cavia porcellus). Has also been encountered in Colombia but not in other parts of the world. Observed in latently infected animals only after spleacetomy. The natural mode of transmission is unknown, though the flea may be a possible vector,

5. Haemobartonella bovis (Donatica and Lestoquard) Weinman. (Donatica and Lestoquard, Bull. Soc. Path. Exot., 27, 1934, 652; Bartonella sergenti Adler and Ellenbogen, Jour. Comp. Path. and Therap, 47, 1934, 221; (?) Bartonella bours Rodriguez, Rev del Inst. Llorente, 18, 1935, 5; abst in Bull Inst. Past., 34, 1936, 1933; Weinman, Trans. Amer. Philosoph. Soc., N. S., 85, 1944, 308; Haemobartonella sergent Weuman, loc. ett., 290; Prom. Latin bos, bovis, ox. ett., 290; Prom. Latin bos, bovis, ox.

Resembles Haemobartonella muris and II. camis. Occurs as rods, occobacilli and coco, singly, in pairs or short chains or groups of 10 or more elements. The rods measure 12 to 2 microns in length and are very slender The coccobacilli occur singly or in pairs measuring 0.3 by 0.6 to 08 micron and the diameters of the cocci are about 0.3 micron. The parasite may occupy a central or marginal position on the red cell, the number on a cell varying from 1 to 20. Not more than 20 per cent of the cells are parasitized.

Using the Romanowsky stain, the organisms stain similarly to the chromatin of Piroplasma spp.

Source and habitat: In the blood of bulls in Algeria and in a non-splenectomized calf in Palestine.

 Haemobartonella sturmanii Grinberg. (Grinberg, Ann. Trop. Med., 35, 1939, 33; Weinman, Trans. Amer. Philosoph. Soc., N. S., 83, 1944, 313.)

Similar to Haemobartonella bovis and M. cants in morphology and staining properties. Occurs as rods, occo-bacilary and coccoid forms, varying in length from 0.5 to 1.5 microns. The number of parasites per infected cell varies from 1 to 15 and they occur individually, scattered irregularly in clumps or sometimes in chains stretching across the cell. At the height of the infection more than 90 per cent of the cells are infected.

Pathogenicity: Causes a temperature rise in buffaloes and slight anemia after durect blood inoculation. Splenectamized rabbits, lumsters and splenectomized calves inoculated with blood from infected buffaloes remained free of the parasite.

Source and habitat: In the blood of buffaloes in Palestine.

 Haemobartonellaperomyschi Tyzzer. (Proc. Amer. Philos. Soc., 85, 1942, 377.)
 Named for the genus of deer mice, Peromuscus.

Occurs as delicate filamentous forms (which may be branched) on the red blood cells. These filaments may become beaded and give rise to a number of coccoids and rods from which ring forms may develop.

Stains by Giemsa's method, but staining process must be intense in order to demonstrate the organism

Pathogenicity: Infection transmissible to splenectomized white rats, white mice and voles, producing a more or less severe illness with anemia.

Habitat: In the blood of the deer mouse (Peromyscus leucopus novaboracensis)

Ta. Haemobartonella peromyscii var. maniculati Tyzzer. (Proc. Amer. Philos. Soc., 85, 1942, 381.) Named for the species of mouse from which it was isolated.

Occurs as rods and filamentous

branched forms. Coarser filaments appear to rise from rounded granules. Delicate rods are preponderant, and minute coccoids appear occasionally. When transferred to the common deer mouse, coarser forms appear, including filaments and large coccoids, sometimes in chains.

Pathogenicity: Pathogenic for graybacked deer mice and the common deer mouse, but non-infective for splenectomized white mice.

Habitat: Blood of the gray-backed deer mouse (Peromyscus maniculatus gracilis).

8 Haemobartonella blarinae Tyzzer (Proc. Amer Philos Soc., 85, 1942, 382) Named for the genus of shrews, Blarina

Extremely pleomorphic with delicate rods and coccus-like forms, often occurring in chains which also contain larger elements which have a deeply stained, bead-like granule. In the early stages of infection they may occur as thick bands or filaments stretching over the red cells usually with a bead or ramule.

The bands take a bluish tint with Gemma's stain, while the more delicate form stains a slaty violet. The head is distinctly reddish. In the fully developed infection, rods and filaments predominate over rounded forms. The organisms may be scattered on the surface of the red cells or may form a dense cap which is intensely stained Rudumentary mycelia may be found radiating from a central portion and reddish stained material with ill-defined contours may occur at the ends of the mycelial branches.

Pathogenicity Pathogenic for the short-tailed shrew but not for deer mice or white mice Causes anemia in the shrew.

Habitat. In the blood of the short-tailed shrew (Blarina brericauda)

9 Haemobartonella sciurit Tyrrer (Proc. Amer. Philos. Soc., 55, 1912, 385.) Named for the genus of gray squirrels, Sciurus.

Very pleomorphie. Occurs as minute rods and filaments which are continuous or segmented. The rods and filaments vary in thickness, some are very uneven and some very coarse Beaded chains may develop from the thickneed forms.

The bead-like elements stain a dull reddish at the perphery with Glemas's stain while the remainder is very faintly stained in contrast to the intensely staining basophile rods and filaments Some of the rounded forms have the appearance of large, thick rings. Beads and rings may arise from slender deeply staining rods, simulating very closely spores within bacilli, though no germination of filaments from them has been observed

Pathogenicity Slightly pathogenic for the gray squirrel, non-pathogenic for normal white mice.

Habitat Blood of the gray squirrel (Sciurus carolinensis leucotis).

Appendix: Here are included (1) Haemobarionella of undetermined specific rank, (2) Haemobarionila-like structures in non-splenectomized mammals and in cold-blooded animals, (3) Invalidspecies (see Weinman, Trans Amer Philosoph Soc, N. S., 55, 1914, 315).

I Hameobartonellae of undetermined specifie rank Microorganisms are grouped according to host of origin and are considered to be lacemobartonellae from the description of the original author; but the information furnished is not sufficient for further classification. Haemobartonellae similar to Hameo

bartonella muris in wild rate. Mus decumanus, Mus noregicus, Ratius ratius frugicorus, Mus ratius grisserenter, Mus ratius ratius, Mus sylenticus. In various ratis, technical names not given.

Haemobartonellae similar to Haemobartonella muris in albino mice. Schilling (Klin Wchuschr, 1929, 55) separated the baemobartonella of the mouse from that of the rat and named it Bartonello muris musculi var. albinoi (Haemobartonella muris musculi var. albinoi Weinman, loc. cet., 290).

Haemobartonellae similar to Haemobarbonella muris in other manmals: Haemobartonella glie glie (Kikuth) Weinman (Bartonella glis glis Kikuth, Cent. f. Bakt., I Abt., 123, 1931, 355; Weinman, loc. ctt., 317) in dormic (Cflis glis).

Haemobartonella opossum (Regondanz and Kikuth) Weiman (Bartonella opossum Regendanz and Kikuth, Arch. f. Schiffs- u. Tropenhyg., 32, 1922, 587; Weimman, loc. cit., 290) in the marsupial rat (Metachirus opossum) and in the opossum (Didelphys didelphys).

Haemobartonella spp. in Lophuromys ansorget, in Lophuromys latteeps, in Contomys latteeps, in Tenemys backsoni, an Arvicanthus striatus, in deer mouse (Peromyseus letwopus novaboracensis), in Chinese hamsters (Cricetulus griseus, Cricetulus griseus, funatus), in Apodemus agrarius and Phodopus praedicetus), and in squirrels (Seurus vulgaris) Mived infections, including haemobartonellae are found in perbos, the gerbille and various rodents (see Weinman, loc. ct., 317-319)

2 Haemobartonella-like structures in non-splenectomized mammals and coldblooded animals

Various bodies whose proper classification in the genus Haemobartonella has not been established (Weinman, loc cit, 319) In non-splenectomized mammals:

Bartonella melloi Yakımoff and Rastegaieff, Bull. Soc Path. Exot., 24, 1931, 471 (Haemobartonella mello: Weuman, loc. cit., 290) in the ant eater (Manis pentadactyla).

Bartonella pseudocebi Pessöa and Prado, Rev. bol c hyg., 1, 1927, 116 (Haemobartonella pseudocebi Weinman, loc. crit, 290) in the monkey (Pseudocebus apella).

Bartonella rocha-lima: Fama and Pinto, Compt. rend. Soc. Biol., Paris, 95, 1926, 1500 (Haemobartonella rocka-limai We man, loc. cit., 290) in the bat (Hei derma brevicauda).

Bartonella sp. in the rat (Ratius ruf cens) and Bartonella sp. in the dormot (Myozus glis).

In cold-blooded animals:

Bartanella parlovskii Epstein, 1 Union. Inst. Exper. Med., Moscow, 193 39s, see Ray and Idnani, Indian Joi Vet. Sci. and Animal Husb. 10, 1910; 25 (Haemobartonella parlovskii, Weinnel loc. cit., 230) in the lamprey (Petromycomarinus).

Bartonella nicollei Yakimofi, Arci Inst. Pasteur Tunis, 17, 1928, 350 (Hamobartonella nicollei Weinman, loc cut 290) in the brochet (Esox lucius).

Battonella ranarum da Gunha an Munez, Compt. rend. Soc. Biol., Paris 97, 1927, 1931 (Haemobartonella ranarum Weisman, loc. cit., 290) in the Irog (Lep todactylus occilatus). This is probably identical with Bartonella batrachoum Zavattari, Boll. d. Soc. ital. biol sper-6, 1931, 121 (Haemobartonella batrachorum Weinman, loc. cit., 290) from the same species.

Bartonella sp in the gecko (Platydec lylus mauritanicus), Bartonella sp. in the lizard (Lacertilla sp.), Bartonella sp. in the lizard (Tropidurus peruianus), Bartonella sp. in the tench (Tinca tinca) and Bartonella sp. in the tortoise (Testudo gracca).

### 3. Invalid species:

Bartonella caviae Campanacci, Atenco parmense, 1, 1929, 99 (Haemobartonella caviae Weinman, loc cit., 290) from the guinea pig.

Bartonella ukrainica Rybinsky, Rev. Microbiol. epidem. et parasitol, 8, 1929, 296 (Haemobartonella ukrainica Weinman, loc. cit., 290) from the guinea pig

Weinman (loc. cit., 314) states that the perasitism of these structures was not proven and no illustrations are furnished by the authors.

#### Genus III. Grahamella Brumpt.

(Brumpt, Bull. Soc. Path. Evot., 4, 1911, 514, Grahamia Tartakowsky, Trav. IX\*Cong. Int. Med. Vet., 4, 1919, 212, not Grahamia Theobald, Colonial Office, Misc. Pub. No. 237, 1909.) Named for G. S. Graham-Smith who discovered the parasite in the blood of voles.

Parasites occurring within the crythrocytes of the lower mammals which morphologically bear a resemblance to Barionella, but which are less pleomorphic, more plump, and more suggestive of the true bacteria. They stain more deeply than bartonellae with Giemea's stain, stain lightly with aniline dyes and with methylene blue. They are Gram-negative, non-scul-fast and non-motile. Splenectory has no effect on the source of infection except in rats. They are non-pathogenic and not affected by arsenicals. Several species have been cultivated on cell-free media. The ctiological agent of grabamellosis of rodents and some other vertebrates.

The type species is Grahamella talpae Brumpt

 Grahamella talpae Brumpt (Bull Soc Path Evot, 4, 1911, 514) Named for the genus of moles, Talpa

Long or short rods of trregular contour lying within the red blood cells, many with a marked curve, often near one of the extremities One or both ends of the longer forms enlarged, giving a wedge or club shaped appearance. Some of the medium-sized forms definitely dumbbellshaped, small forms nearly round.

With Giemsa's stan, the protoplasm of the organism stams light blue, with darker areas at the enlarged ends. Dark staining areas of longer forms give the organism a banded appearance. Length varies from 0.1 to 1 micron. Transition occasionally free in the playma, but usually in groups. Most of the infected corpuseles contain between 6 and 20 parasites (Graham-Smith, Jour. II)g. 5, 1900, 453).

Pathogenicity Pathogenic for moles

Appendix: In addition to Grahamella talpae Brumpt, descriptions of the following species occur in the literature The list may not be complete and the validity of these species may be ques-

Grahamella acodoni Carini (Ann. Parasit, 2, 1921, 253) From Acodon serrensis, Brazil

Grahamella alactagae Tartakowsky. (Katalogue der Exponaten der Landwirthschaftlichen Ausstellung (Russisch), 8t Petersburg, 1913) From Alactaga satirens and Alactaga aconitus in Transcaucasia and steppes of Astrakhan (Alactaga misspelled Alractaga) Quoted from Yakimoff, Arch f Protistenk., 66, 1929, 303

Grahamella arralis Tartakowsky. (Katalogue der Exponaten der Landwirthschaftlichen Ausstellung (Hussisch) St. Petersburg, 1913 ) From Mierotus arculis in Transcauciasia. Quoted from Yakimoff, Arch. f. Protistenk., 66, 1929, 201

Grahamella baljourn Brumpt (Grahamella sp Ballour, Rept., Welloem Tropneal Research Laboratory, 2, 1996, 97, Grahamella balfourn Brumpt, Bull. See Path Lvot, Paris, 4, 1911, 517) From the desert rat (Jaculus jaculus) in the Sudan

<sup>\*</sup> Tyzzer (Proc. Amer. Philos. Soc., 83, 1912, 373) finds that grahamellae isolated in culture show a close relationship to Streptobacillus monifigerate (Actinomices muris) and proposes the inclusion of the genus Grahamella in the family Actinomycelaceae. The latter relationship appears to be very doubtful.

Grahamella Ularinae Tyzzer. (Proc. Amer. Philos. Soc., 85, 1912, 370.) From the short-tailed shrew (Blarina brevicauda) in Massachusetts.

Grahamella bours Marzinowsky. (Med. Obosrenie, 1917, No. 1-2.) From the ox (Bos taurus) in Russia. Quoted from Yakimoff, Arch. f. Protistenk., 58, 1929, 304.

Grahamella brumpti: Ribeyro and del Aquilla. (Ann. Fac. Med., Lima, 1, 1918, 14-20.) From Desmodus rufus in Peru.

Grahamella cants lupus Kamalow. (Cent f. Bakt., I Abt , Orig., 128, 1933, 197) From the wolf, Tiflis.

Grahamella couch: Neitz. (Onderst. Jour Vet Sci. and An Ind., 10, 1938, 29.) From the multimammate mouse (Mastomus coucha) in South Africa.

Grahamella criceti domestics Parawanicke. (Das Material zum Hämoparasitismus der Tiere bei Uns. Tiffis, 1925.) From Cricetus domesticus in Transcaucasia. Quoted from Yakimoff, Arch f. Protistenk, 66, 1929, 301

Grahamella ericetuli Patton and Hindle. (Proc. Roy. Soc., London, B(100), 1926, 387) From Cricetulus griseus in China

Grahamella dschunloveski: Tartakowsky. (Grahamia sp., Dschunkowsky and Luhs, Trav IX. Cong Internat Med. Vet., 1909, 4, 1910, 242, Grahamia dschunlouvski: Tartakowsky, 1910) From the bat (Vezpertitio noctula) in Transcaucasia Ref. to Tartakowsky quoted from Yakimofi, Arch i Protistenk, 68, 1929, 304.

Grahamella dudtschenkoi Yakımoff (Grahamella sp. Dudtschenko, Cent. f. Bakt, I Abt, Orig. 74, 1914, 291; Grahamella dudtschenkoi Yakimoff, Arch f Protistenk., 68, 1929, 301) From the hamster (Crnetiulus sp.) in Transbaikal.

Grahamella ehrlichi Yakimoff. (Grahamella ehrlichi Yakimoff, Arch f Protistenk., 66, 1929, 305.) From the perch (Perca fluviatilis) in Russia. Grahamella francai Brumpt. (Grahamella sp. Franca, Arch. Inst. Bacter Camara, Pestana, 3, 1911, 277; Graha mella francai Brumpt, Précis de Parasi tologie, 24me éd., 1913, 192.) From the jumping rat (Eliomys quercinus) in Portugal.

Grahamella gallinarum Carpano. (Ann Parasit. hum. et comp., 13, 1935, 238.) From leghorn chickens in Egypt.

Grahamella gerbilli Sassuchin. (Grahamia gerbilli Sassuchin, Arch. f. Protistenk., 74, 1931, 526.) From Gerbillus lamaricinus in southeast Russia.

Grahamella hegneri Sassuchin (Grahamia hegneri Sassuchin, Arch. f. Protistenk., 75, 1931, 152.) From Citellus pygmaeus in Russia.

Grahamella joyeuz; Brumpt. (Grahamella sp., Joyeux, Bull. Soc. Path Exot., Paris, 6, 1913, 614; Grahamella joyeuzi Brumpt, Préess de Parasitologie, 24me éd., 1913, 192.) From Golunda fallaz and Mus rattus in Fronth Guinea.

Grahamella merionis Adler. (Trans-Roy. Soc. Trop. Med., 24, 1930, 78) From Meriones tristrami in Palestine.

Grahamella microti Lavier. (Bull. Soc. Path Exot., Paris, 14, 1921, 573.) From Microtus arralis in France.

Grahamella micrott pennsylvanici Tytzer. (Proc Amer. Philos Soc, 85, 1912, 366) From the common vole (Microtus pennsylvanicus pennsylvanicus) in Massachusetts.

Grahamella muris Carini (Bull. Soc Path. Exot., Paris, 8, 1915, 104) From the house rat (Mus decumanus) in Brasil

Grahamella muris muscul berica Parzwanidze. (Das Material zum Hanoparasatismus der Tiere bei uns Thüs, 1925) From Mus musculus in Trauscaucasia Quoted from Yakimoff, Arch f. Protistenk, 65, 1929, 303.

Grahamella musculı Benoit-Bazille. (Bull Soc. Path. Exot , Paris, 15, 1920, 408.) From Mus musculus var albinos in France.

Grahamella ninge lohl-yalomoti Yakimoff. (Bull. Soc. Path. Evot., Paris, 10,

1. Pseudomonas aeruginosa (Schroeter) Migula. (Bacterium aeruginosum Schroeter, in Cohn, Beitrage z Biologie. 1, Heft 2, 1872, 126; Bacillus pyocyaneus Gessard, Compt rend. Acad. Sci., Paris, 94, 1882, 536; Micrococcus pyocyaneus Zopf, Spaltpilze, 2 Aufl , 1884, 83; Bacıllua aeruginosus Trevisan, Atti Accad. Fis -Med Stat., Milano, Ser. 4, 3, 1885, 11; Bacillus fluorescens Crookshank, Man. of Bact., 3rd ed , 1890, 247; not Bacillus fluorescens Bergev et al., Manual, 1st ed , 1923, 287; Pseudomonas procuanca Migula, in Engler and Prantl. Die natürl, Pflanzenfam, 1, 1a, 1895, 29, Bacterium pyocyaneum Lehmann and Neumann, Bakt Diag , 1 Aufl , 2, 1896, 267; Migula, Syst. Bakt , 2, 1900, 884) From Latin, full of copper rust, or ver-

digris; green
Rods: 05 to 06 by 15 microns, occurring singly, 1n pairs and short chains.
Motile, possessing one to three polar
fiagella. Monotrichous (Reid, Naghski,
Farrell and Haley, Penn Agr Exp Sta,
Bull 422, 1942, 6). Gram-negative.

Gelatin colonies Yellowish or greenishyellow, fringed, irregular, skein-like, granular, rapidly liquefying.

Gelatin stab: Rapid liquefaction The fluid assumes a yellowish-green or bluish-green color.

Agar colonies Large, spreading, grayish with dark center and translucent edge, irregular. Medium greenish

Agar slant: Abundant, thin, white, glistening, the medium turning green to dark brown or black, fluorescent.

Broth: Marked turbidity with thek pellicle and heavy sediment. Medium yellowish-green to blue, with fluorescence, later brownish. Produces pyocyanin, fluorescein and pyrorubrin (Am Jour. Hyg., 5, 1925, 707).

Litmus milk: A soft coagulum is formed, with rapid preponization and reduction of litmus Reaction alkaline. Potato: Luxuriant, dirty-brown, the

medium becoming dark green.

Indels usually not formed (Sandife

Indole usually not formed (Sandiford, Jour. Path, and Bact., 44, 1937, 567). Nitrates are reduced to nitrites and nitrogen.

Glucose, fructose, galactose, arabnose, maltose, lactose, sucrose, dextrin, nulin, glycerol, mannitol and dulcitol are not attacked Acid from glucose (Sandiford, loc. cit.).

Blood serum: Liquefied. Yellow liquid, greenish on surface.

Blood hemolyzed.

Cultures have marked odor of trimethylamine.

Aerobic, facultative

Optimum temperature 37°C.

Pathogenic for rabbits, guinea pigs, rats and mice.

Common name: Blue pus organism.

Source: Pus from wounds Regarded as identical with one of the plant pathogens (Pseudomonas polycolor) by Elrod and Braun (Jour. Bact, 44, 1942, 633).

Habitat Cause of various human and animal lesions. Found in polluted water and sewage

2. Pseudomonas jaegerl Migula. (Bacillus proteus fluorecens H Jaeger, Ztechr f. Hyg., 12, 1892, 593; Migula, Syst. d. Bakt., 2, 1900, 883; Bacillus proteus-fluoreacens Holland, Jour. Back., 5, 1920, 220; Proteus fluorescens Holland, bid., 224; Pseudomonas protea-fluorescens Holland, thid, 224; Pseudomonas protea-fluorescens Holland, thid, 224) Named for H. Jaeger who first described the species. Short, thick rods, with rounded ends, occurring snegly and in pairs. Motile with a tult of polar flagella which may be pushed to one side where cells remain in a chain. Gram-neative.

Gelatin colonies: Small, transparent, becoming proteus-like.

Gelatin stab: Marked surface growth. Saccate to infundibuliform liquefaction Liquefied portion green fluorescent.

Agar slant: Thick, yellowish-white layer, the medium becoming greenishfluorescent. At times gas is formed

Broth: Turbid, with greenish-gray pel licle and sediment.

Litmus milk: Not coagulated.

 Eperythrozoon coccoldes Schilling. (Schilling, Klin. Wchnscht., 1928, 1854; Gyromorpha musculi Dinger, Nederl. tijdschr. geneesk., 72, 1923, 5905.) From Greek, coccus-shaped.

In stained blood films these organisms appear as rings, executed and rods, the majority as rings of regular outline with clear centers. They are in the plasma and on the red cells. Measure 0.5 to 1.4 microns in greatest dimension.

Stain pale red or reddish-blue with the Giemsa or the May-Grunwald-Giemsa technics. Gram-negative.

Suggested methods of multiplication by binary fission, budding, development of small coccoidal to annular forms.

of small coccordal to annular for Cultivation: Negative results.

Immunology: Immunological state in animals that of the premunition type. Latent infection in mice which is made manifest by splenectomy.

Pathogenicity: Pathogenic for white mice, rabbits, white rats, wild mice, usually in young animals or in spleneetomized adults.

Source: Blood of splenectomized white mice.

Habitat: Blood of infected animals, mouse louse (Polyplax serrata) and probably other arthropods.

Eperythrozoon ovis Nestz, Alexander and Du Tost. (Neitz et al., Address, Biological Society, Pretoria, Mar 15, 1934; from Neitz, Onderst. Jour. Vet. Sci. and An. Ind., 9, 1937, 9.) From Latin ovis, sheep.

Delicate rings approximately 05 to 1.0 micron in duameter though occasionally larger. In addition there are triangles with rounded angles, ovoid, comma, rod, dumbbell and tennis racket forms. Found supra-cellularly on the erythrocytes but often free. Colored pale purple to pinkish-purple with Giemsa's stain Suggested mode of multiplication by budding.

Cultivation · Negative results.

Immunology: Immunological state in sheep appears to be that of the premunition type.

Pathogenicity: Sheep, antelopes and probably goats and splenectomized cives are susceptible. Dogs, rabbits and guinea pigs are refractory. The distinctive feature of Eperythrozon oris is its ability to provoke illness in normal animals without resorting to splenectomy.

Source: Blood of infected South Afri-

can sheep.

Habitat: Blood of infected animals. No ectoparasites found on sheep naturally infected, but an arthropod is suspected.

 Eperythrozon wenyonii Adler and Ellenbogen. (Adler and Ellenbogen).
 Jour. Comp. Path. and Thenp., 47, 1934 (Sept. 3), 220; see Bartonella wenyoni in appendix.)
 Named for Dr. C. M. Weavon. a student of these orranisms.

You, a student of these organisms. Morphologically similar to Eperphrazoon coccoides. Coccoid and often resicular, staining pale red with Gennsi's
stain and varying from 0.2 to 1.5 microns
in diameter. Multiplication seems to
be by budding and fassion, and by filamentous growths from the ring forms, suggesting resemblance to Hyphomycetes. Up to 50 or 60 parasites are found on one cell.
These are arranged in irregular chains or
in tightly nacked groups.

Cultivation not reported.

Immunology. The organism creates a state of premunition and latent infection is made manifest by splenectomy.

Pathogenicity: Cattle are susceptible, but sheep are not infected either before or after splencetomy.

Source Blood of infected cattle. Habitat: Blood of infected cattle, arthropod transmission not proven.

4. Eperythrozoon varians Tyszer. (Proc Amet Philos. Soc., 85, 1942, 337.) From Latin varians, varying. 1917, 99.) From the hamster (Cricetus phoce) in Transcaucasia.

Grahamella peromyse: Tyzzer (Proc. Amer. Philos. Soc., 85, 1912, 363) From the deer mouse (P. leucopus noraboracensis) in Massachusetts

Grahamella peromyses var. maniculati Tyzzer (Proc. Amer. Philos. Soc., 85, 1942, 365) From the gray-backed deer mouse (Peromyseus maniculatus) in Massachusetts.

the Peruvian mouse (Phyllotis darwini

Grahamella phyllotidis Tyzzer (Proc. Amer. Philos Soc., 85, 1942, 371) From

Imptus).

Grahamella pipistrelli Markow. (Grahamıs pipistrelli Markow, Russian Jour. Trop. Med., 1926, No. 5, 52) From the

bat (Pspistrellus nathussi) in Russia. Grahamella rhesi Leger. (Bull. Soc.

Path Exot., Paris, 15, 1922, 680.) From the monkey (Macacus rhosus) in Annam. Grahamella sani: Cerruti. (Arch. Ital.

Grahamella sanii Cerruti. (Arch. Ital. Sci. Med. Col., 11, 1930, 522) From Testudo gracca in Sardinia

Grahamella talassochelys Cerruti. (Arch Ital Sci. Med. Col., 12, 1931, 321) From Tallasochelys caretta in Sardinia. (Misspelled for Thalassochelys.)

## Genus IV. Eperythrozoon Schilling.\*

(Schilling, Klin. Wchnschr., 1928, 1851, Gyromorpha Dinger, Nederl. tijdschr., geneesk., 72, 1928, 5903.) From Greek meaning animal on red blood cell.

Microscopic blood parasites found in the plasms and on the crythrocytes. They stain well with Romanowsky type dyes, and then appear as rinas, occordis or short rods, I to 2 microns in greatest dimension, staining bluish or pinkish violet. They show no differentiation of nucleus and cytoplasm. The organisms are not known to retain the violet in Gram's method or to be acid-dichol-fast. Splenectomy activates latent infection Not cultivated in cell-free media. Arthropod transmission has been established for one species (Weinman, Trans. Amer Philosoph. Soc., N.S. 55, pt. 3, 1944, 321)

The type species is Eperythrozoon coccoides Schilling.

## Key to the species of genus Eperythrozoon.

I. Etiological agent of eperythrozoonosis of white mice

1 Eperythrozoon coccoides.

II. Etiological agent of eperythrozoonosis of sheep.

2. Eperythrozoen oris.

III. Etiological agent of eperythrozoonosis of cattle
3 Eperythrozoon wenyonie.

IV. Etiological agent of eperythrozoonosis of gray-incked deer mice

4. Eperuthrozoon varians.

V. Etiological agent of eperythrozoonosis of voles and dwarf mice 5 Eperuthrozoon dispar.

<sup>\*</sup> This genus has been considered as belonging to the Protozoa by Neitz, Alexander and Du Tout (Onderst J. Vet Sci. 5, 1931, 283) and to the bacteria by Mesnii (Bull. Soc. Path. cont., 22, 1923, Saland by Tyzer (in Weinman, Trans. Amer. Philosoph. Soc., N.S., 33, pt. 3, 1914, 241) The evidence at hand favors the inclusion of this group among those organisms which are not protozoan in nature but which are closely related to bacteria.

#### FAMILY III. CHLAMYDOZOACEAE MOSHKOVSKY.\*

(Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 12.)

Small, pleomorphie, often coccoid microorganisms usually with characteristic development evele. Stain with aniline dyes. Gram-negative. Behave as obligate intracytoplasmic parasites Have not been cultivated in cell-free media. Criteria adequate for classification lacking for more recently isolated members. The attribution of Genus III, Colesiota, either to Richettsiaceae or to Chlamydozoaceae is still in doubt.

Key to the genera of family Chlamydozoaceae.

I. Cells coccoid and with life evele.

A. Non-cultivatable in chicken embryonic tissues.

Genus I. Chlamydozoon, p. 1114.

B. Cultivatable in chicken embryonic tissues. Genus II. Miyagawanella, p. 1115.

II. Cells pleomorphic.

Genus III. Colesiola, p. 1119.

Genus I. Chlamydozoon Halberstaedter and von Prowazek.

(Arb. a. d. kaiserl. Gesundheitsamte, 26, 1907, 44.) From Greek chlamydos, closk and zoon, animal.

Coccoid spherical cells with developmental cycle. Gram-negative. Intracytoplasmic habitat. Non-cultivatable in chicken embryonic tissues. Susceptible to sulfonamide and penicillin action.

vated,

The type species is Chlamydozoon trachomatis Foley and Parrot.

1. Chlamydozoon trachomatis Foley and Parrot. (Richettsia trachomae Busacca, Arch. Ophthalm., 52, 1935, 567; Foley and Parrot, Arch. Inst. Past. d'Algeric, 15, 1937, 339; Rickettsia trachomatis Foley and Parrot, idem.) Named for the disease, trachoma.

Coccoid bodies: Small microorganisms 200 to 350 millimicrons in diameter form the elementary bodies. Initial bodies up to 800 millimicrons in diameter and plaques up to 10 microns also found. All larger forms encapsulated with substance derived either from the agent or from the cytoplasm of the parasitized cells. Elementary body is the basic unit. Paired forms or clusters occur. Gramnegative. Stains poorly with aniline dyes; blue or reddish-blue with the Giemsa stain and red or blue, depending on the metabolic state, with the Macchiavello stain. Matrix of plaques gives a strong reaction for giveogen. motile.

Cultivation: Has never been culti-

Immunological aspects: Has one or more antigens in common with or closely resembling one or more present in Miyagawanella spp. Produces, in low concentrations, antibodies which fix complement with antigen from Miyagawanella lymphogranulomalis.

Pathogenicity: Pathogenic for man, apes and monkeys where it affects only

Prepared by Dr. Geoffrey Rake, The Squibb Institute for Medical Research, New Brunswick, New Jersey, September, 1946.

Occur in rings, coccoids of varying size, some very minute, bacillary forms

Many of the baciliform elements show an unstained leas-like swelling, indicating the formation of a ring within the substance of the rod. At the height of the infection most of the organisms are found in the plasma. Whenever an organism comes in contact with a red cell, it stains intensely

Pathogeness. Pathogenic for the graybacked deer mouse (causing anemia) and for the splenectomized common deer mouse Not pathogenic for splenectomized white mice

Habitat: Blood of the gray-backed deer mouse (Peromyscus maniculatus gracilis).

 Eperythrozoon dispar Bruynoghe and Vassiliadis (Ann. de Parasitol , ?, 1929, 353)

Resembles Epertythrozon, coccaides in etaining, distribution on the crythrocytes and also in appearance except that circular disks with solid etaining centers may greatly outnumber the ring forms. Found on the red blood cells and in the plasma. Size range that of Eperythrozonoccoudes, also some larger ring forms.

Cultivation: Not successful.
Immunology, Infection is followed by

ammunology, intection is totlowed by premunition and latent infection is made manifest by splenectomy. Splenectom-ried rabbits premunized against E coccoides do not react to inoculation with E, dispar, if the latter is injected first, they do not react to E occoides

Infectivity Infective for the European vole (Arricolal Vicentus) arratis), the American vole (Microtus pennsylvanicus pennsylvanicus), the dwarf mouse (Mus minutus), the rabbit, and Mus acomys

Not infective for albino rats or albino

Source: Blood of infected animals.

Appendix: 1) Species incompletely studied, Eperythrozoon spp. and Eperythrozoon-like structures (Weinman, Trans Amer Philosoph. Soc., N. S. 35, pt 3, 1944, 320).

Eperythrozoon noguchii Lwoff and Vaucel. (Bull Soc path. evot. 26, 1933, 397) Probably not a valid species.

Eperythrozoon perekroposi Yakimoff. (Arch. f. Protistenk., 73, 1931, 271.) Classification in genus Eperythrozoon questionable.

Bartonella wenyom Nieschulz. (Ztschr. f. Infektionskr., 53, 1938, 178.) Probably identical with Epcrythrozon wenyon: If valid, Hacmobartonella wenyoni.

Possible human infection (Schüffner, Nederl. tijdschr. v. geneesk., 73, 1939, 3778).

2) Animals infected with parasites which are definitely eperythrozoon-like but of uncertain specificity or which are eperythrozoon-like in some features but which can not be definitely classified generically.

Jerbos sp. Kikuth. (Cent. f. Bakt., 1 Abt., Orig., 125, 1931, 356.) Arricola arcalis Zuelzer. (Zuelzer.

Cent f. Bakt, I Abt., Orig, 102, 1927, 419, Kikuth, Ergebn Hyg. Bakt., Immunitatsforsch u Exper. therap., 13, 1932, 559.)

Rattus rattus Schwetz. (Ann. Soe beige de med. trop., 14, 1931, 277) Schurus euigeris Nauck. (Arch f. Schullis u. Trop. 119g., 34, 1927, 322.) Leplodactiglus pentadectiglus Carini. (Compt. rend. Soc. Biol., Paris, 103, 1930, 1312.)  Miyagawanella lymphogranulomatis Brumpt, (Brumpt, Ann. de Parasit., 16, 1938, 183; Ethichia lymphogranulomaiosis Mauro, (Reference not found.) Named for the disease, lymphogranuloma.

Coccoid bodies: Small microorganisms 200 to 350 millimicrons in diameter form the elementary bodies. Initial bodies up to 1 micron and plaques up to 10 microns also found. All larger forms encapsulated with a substance derived either from the agent or from the cytoplasm of parasitized cells. Elementary body is the basic unit. Paired forms or clusters occur. Gram-negative. Stain with aniline dyes, purple with the Giemsa stain and red or blue, depending on metabolic state, with the Macchiavello stain. Matrix of the plaque does not give the reaction for glycogen Non-motile.

Filterability. Passes through Chamberland L<sub>2</sub> and L<sub>3</sub>, Berkefeld V and N and sometimes through Seitz EK filters.

Cultivation: In plasma tissue cultures of mammalian cells, in mammalian cells on agar, in the chorio-aliantoic membrane or particularly in the yolk see of the chicken embryo but has not been cultivated in the allantoic sac. Optimum temperature 37°C in tissue cultures, 35°C in the chicken embryo.

Immunological aspects. Has one or more antigens in common with or closely resembling one or more present in the chlamydozoa and other miyagawanellae. Antisera against any of these two genera react with antigens from Miyagawanella lumphogranulomatis or the other miyagawanellae thus far tested. One common antigen has been isolated as a soluble fraction distinct from the bodies of the agent. Distinguished sharply from the other miyagawanellae by antitoxic neutralization of toxic factor or by neutralization of infections in mice with chicken Evidence exists that these antisera

two serological reactions are with distinet specific antigens. Immunity in man or animals is probably poor in the absence of continuing apparent or inapparent infection.

Toxic factor: Infected yolk sac or yolk injected intravenously or intratraperitioneally is rapidly fatal to mice. Produces characteristic lesions on the skin of normal guines pigs.

Pathogenicity: Pathogenic for man, apes, monkeys, guinea pigs, otton rats, hamsters, mice, chicken embryos. In-apparent infections may occur with the agent hatbored in the organs. Causes local genital lesions, septicemia, lymphadenitis, meningitis, ophthalmitis and rarely bneumonitis in man.

Tissue tropisms: In laboratory rodents this species is infective by the intranasal (pneumonitis), the intracerebral (meningitis) and the intradermal routes.

Chemotherapy: Susceptible to relatively high concentrations of penicillin, to the sulfonsmides and to some antimony compounds.

Source: Most commonly the genital secretions of infected individual or the draining lymph nodes. Also occasionally in blood, spinal fluid and ocular secretions.

Habitat: The etiological agent of lymphogranuloma venereum, lymphogranuloma inguinate, climatic bubo, esthiomène and some forms of anorectal inflammation.

 Miyagawanella psittaci (Lillie) Moshkovsky. (Rickettsia psittaci Lillie, Publ. Health Repts., 45, 1930, 773;
 Microbacterium multiforme psittacosis Levinthal,\* 1st Cong. internat. de Microbiol., 1, 1930, 523; Moshkovsky, Uspekhi Souremennoi Biologii (Russian) (Advances in Modern Biology), 19, 1945, 12; Ehrlickia psittaci, an order of birds.

<sup>\*</sup> This is the type species of the genus Microbacterium Levinthal which is invalid because of the earlier Microbacterium Orla-Jensen, 1919, see p. 370.

the cornea and conjunctive causing highly destructive lesions.

Chemotherapy: Susceptible to sulfonamides and penicillin.

Source: Found in scrapings of cornea or conjunctiva in cases of trachoma.

Habitat: The etiological agent of trachoma in man.

 Chlamydozoon oculogenitale Moshkovsky. (Moshkovsky, Uspekhi Souremennoi Biologii, 19, 1945, 12) Fron Latin oculus, eye and genitalis, genutal. Morphology and staining reactions

Morphology and staining reactions.

As for Chlamydozoon trachomatis.

Cultivation: Has never been cultivated. Immunological aspects: As for C. trachomatis.

Pathogenicity: Pathogenic for man, baboons and monkeys. Causes an acute conjunctivitis and, in man, an inflammation of the lower genito-urinary tract.

Chemotherapy: Susceptible to sulfonamides and peniculin.

Source Found in conjunctival exudates, and in exudates from infected urethrs or cervix. Also present in contaminated pools of water

Habitat The etiological agent of swimming pool conjunctivitis, neonatal conjunctivitis or inclusion conjunctivitis.

#### Genus II Miyagawanella Brumpt

(Ann. de Parasit., 18, 1933, 153.) Named for Prof. Miyagawa, the Japanese bacteriologiat, who first (1935) grew the type species in the chick embryo.

Coccoid to spherical cells with a developmental cycle. Gram-negative. Intracytoplasmic habitat. Cultivatable in chicken embryonic tissues. Some species are susceptible to sulfonamide or pecicialin action.

The type species is Mivagawanella lymphogranulomatis Brumpt

#### Key to the species of genus Miyagawanella.

- I The etiological agent of lymphogranuloma venereum, lymphogranuloma inguinale, climatic bubo, and esthiomène in man
  - Mayagawanella lymphogranulomatis.
- II. The etiological agent of puttacosis or parrot fever.

  2. Munagawanella puttaci.
- III. The ctiological agent of ornithosis (Meyer).
- 3 Mayagaranella ornathosis.

  IV. The etiological agent of one type of varal pneumonia.
  - 4. Mayagawanella pneumoniae
- V. The ctiological agent of mouse pneumonitis (Gönnert)
- 5. Myggaranella bronchopneumoniae, VI. The etiological agent of feline pneumonitis (Baler).
  - 6. Mayagawanella felis
- VII. The etiological agent of Louisiana pneumonia
  7. Mayagaranella louisianae,
- VIII. The etiological agent called the Illinois virus, the cause of one type of viral pneumonia.
  - 8. Miyagawanella ıllini.

 Miyagawanella pneumoniae Rake, spec. nov. Named for the disease, pneumonia.

Coccoid bodies: As for Miyagawanella lymphogranulomatis but slightly smaller, circa 200 millimicrons in diameter.

Cultivation As for Mayagawanella psittaci.

Immunological aspects: As for Miyagawanella psillaci. Distinct from Miyagawanella ornuthosis by the neutralization test with chicken antisera.

Pathogenicity Pathogenic for birds, man, cotton rats, hamsters, white rats, kangaroo rats, mice and chicken embryos Causes a fatal pneumonitis in man.

Tissue tropisms As for Miyagawanella ornithosis Chemotherapy. As for Miyagawanella

ornithosis.

Source: Occurs in lungs of infected hu-

mans. Possibly originally of avian origin.
Habitat. The citological agent of one
type of viral pneumonia. The type strain
is the so-called strain S-F (Eaton, Beck
and Pearson, Journ. Exp Med, 73, 1941,
641)

5 Miyagawanella bronchopneumoniae Moshkovsky (Moshkovsky, Uspekhi Souremennoi Biologii, 19, 1945, 19, Ehrlichia bronchopneumoniae Moshkovsky, idem.) Named for the disease, bronchopneumonia

Coccoid bodies As for Miyagawanella pneumoniae.

Cultivation As for Miyagawanella lymphogranulomatis Does not grow in the allantoic cavity of the chick.

Immunological aspects As for Mayagawanella lymphogranulomatis but no soluble antigen has been demonstrated.

Toxic factor Heavily infected yolk saes and yolk injected intravenously are very rapidly fatal to mice.

Pathogenicity. Pathogenic for mice, by ors and ferrets Produces a modeq, severe pneumonitis

Sue tropisms. Shows a predilection

for the lungs. In mice, it is also infective by the intravenous route.

Chemotherapy: Susceptible to sulfonamides and to relatively large doses of penicillin.

Source: Found in lungs of certain stocks of the laboratory mouse.

Habitat: The agent of mouse pneumonitis Bronchopneumonie virus (Gönnert, Cent. f. Bakt., I Abt., Orig., 147, 1941, 151).

 Miyagawanella felis Rake, spec. nov. From Latin felis, cat.

Coccoid bodies: As for Miyagawanella lymphogranulomatis.

Cultivation: As for Miyagawanella psitlaci.

Immunological aspects: As for Miyagawanella psittacs but nothing knowa about inapparent infections in the natural host, the domestic cat.

Toxic factor: Infected yolk sac or other membranes and yolk or other fluids, injected intravenously into mice or chicken embryos or intraperitoneally into mice are rapidly fatal.

Pathogenicity. Pathogenic for cats, hamsters, mice and chicken embryos. Causes a fatal pneumonitis with acute conjunctivitis in cats.

Tissue tropisms: Prediliction for lungs and conjunctivae. In laboratory redents, this species is infective by the intranasal, intraperitoneal, intracerebral and intravenous routes.

Chemotherapy: As for Miyagawanella ornulhosis

Source: Lungs of infected cats.

Habitat. The etiological agent of one form of cat nasal catarrh, influenza or distemper (Baker, Science, 96, 1942, 475) and feline pneumonitis.

7. Miyagawanella louisianae Rake, spec. nov. Named for the State of Louisiana.

Coeroid bodies As for Miyagawanella psitlaci.

Coccoid bodies: As for Miyagawanella lymphogranulomatis.

Filterability: Partly filterable through Berkefeld N, Chamberland L and Q or Seitz EK filters.

Cultivation: As for Miyagawanella lymphogranulomatis but grows readily in

allantoic sae without adaptation
Immunological aspects As for M
lumphogranulomatis but no soluble frac-

tion yet demonstrated.

Toxic factor. Infected yolk sac or yolk injected intravenously or intrapertoneally is rapidly fatal to mice.

Pathogenicity Pathogenie for birds (particularly psittanue and finch species), man, monkeys, guinea pigs, pocket gophers, hamsters, white rats, kangaroo rats, mice, rabbits and chucken embryos Inapparent infections may occur with the agent harbored in the organs Causes a highly fatal pneumonities with septemian man

Tissue tropisms: Causes a septicemia In man this species shows predilection for the respiratory tract. In laboratory rodents, it is infective by the intransati, the intraperitoneal (pertionities and septicemia), the intracerebral and the intravenous routes.

Chemotherapy Susceptible to relatively high concentrations of penicillin Some strains are susceptible to sulforamides.

Source: Found in the organs and nasal secretions of infected birds and, from the latter, spreads to the plumage by preening and other methods. Plentiful indropings or dust from infected eages. Relitively resistant under such conditions

Habitat: The etiological agent of pair tacosis or parrot fever. Also of some cases of atypical pneumonia.

3. Miyagawanella ornithosis Rake. spec nor. From Greek ornithos, bird.

Coccoid bodies: As for Viyagawanella lymphogranulomatis.

Cultivation: As for Mayagawanella prittaci,

Immunological aspects: Has one or more antigens in common with, or closely resembling, one or more present in chlamydozoa and other miyagawanellae as shown by a cross reaction in complement fixation tests Sharply distinguished from other mivagawanellae by toxinantitoxin neutralization or by neutralization of infection in mice with chicken antisera The latter test however suggests that the agent of meningopneumomitis (Francis and Macill, Jour Exp. Med , 68, 1938, 147) is this species rather than something distinct Immunity in man or animals is probably poor except in the presence of continuing apparent or inapparent infections Cross reactions suggest that Miyagau anella ornithoses may be more closely related to Mayagau anella lymphogranulomatis than is M pattact

Toxic factor As for Miyagawanella

Pathogenetty Pathogene for birds (especially non-pathenes species), man, ferrets, guinea pigs, hamsters, white rats, kangaroo rats, mee, rabbits and checken embros Inapparent infections may occur Causes a moderately severe pneumonius with septicema in man
Tissue tropisms. Causea a septicema

In birds and man shows a predilection for the lungs in laboratory rodents, this species is infective by the intransal, intracerbral, intravenous and (with relatively large morula of most strains) intraperatonical routes

Chemotherapy Susceptible to relatively large doses of penicillin Not susceptible to sulfonamides

Source Found in organs and nasal secretions of finches, pheasants (including domestic chickens), domesticated doves, fulmar petrels and other birds. Spreads from the secretions to plumage and droppings.

Habitat The ctological agent of ornithosis (Meyer) and meningopneumonitis (Francis and Magill). Habitat: Found in scrapings of cornea or conjunctive or in discharges from affected eyes. Etiological agent of infectious or specific ophthalmia in sheep, cattle and goats.

2. Colesiota conjunctivae-gallit (Coles) Rake, comb. nov. (RicLettsia conjunctivae-galli Coles, Onders. Jour. Vet. Sci. and Indust., 14, 1940, 469.) From conjunctiva and Latin gallus, hen.

Pleomorphie bodies: Similar to Colesiota conjunctivae. Stain purplish-red or blue with the Giemsa stain.

Cultivation: Has never been cultivated.

Immunological aspects: Unknown.
Pathogenicity: Pathogenic for the do-

Pathogenicity: Pathogenic for the domestic fowl. Causes an acute conjunctivitis and keratitis. Tissue tropisms: As for Colesiata conjunctivae.

Source: As for Colesiota conjunctivae Habitat: The etiological agent of one form of ocular roup in fowls.

Appendix: The following are similar to or identical with the above:

Rickettsia conjunctivae-boris (Coles, South Afr. Vet. Med. Assoc., 7, 1936, 1) cannot be distinguished from Colesiala conjunctivae by any described characteristics.

Richettsia lestoquardi Donatien and Gayot. (Bull. Soc. Path. Exot., 55, 1942, 325.) Found in benign comunctivitis in swine similar to that which occurs in ruminants. Filterability: Filters through Berkefeld N and Mandler 6, 7 and 9 filters. Cultivation: In the volk sac of the

chicken embryo.

Immunological aspects: Indistinguishnble from other miyagawanellae by complement fixation tests with yolk sac antigens. Partly distinguished from Mryagawanella pstitaci and M. ornifosiby active immunization in mice and cuinca piez

Pathogenicity: Pathogenic for man, guinea pigs, cotton rats, mice and chicken embryos. Slightly pathogenic for white rats, golden hamsters and deer mice. Macacus rhesus monkeys, rabbits, mushrats and nutra are unaffected. Causes a highly fatal pneumonitis and septicemia in man.

Tissue tropisms. Causes a septicemia. In man this species shows predilection for the respiratory tract. In laboratory rodents it is infective by the intranasal, intraperitoneal, intracerebral, intramuscular and subcutaneous routes.

Chemotherapy. As for Miyagawanella ornsthosis,

Source: Sputum and organs of infected persons. Habitat: The etiological agent of Louisiana pneumonia (Olson and Larson, U. S. Pub. Health Repts., 59, 1944, 1373), so-called Borg strain.

8. Miyagawanella Illini Rake, sprc.

Coccoid bodies. As for Miyagawanella lymphogranulomatis

Filterability Passes through Berkefeld N or W filters.

Cultivation: In the yolk sac of chicken embryo,

Immunological aspects Distinguished mother myagwanellae by neutralization tests in mice with chicken antisera and partly from Miyagawanella psitaci, M. ornithosis and M. pneumonia by active immunization in mice.

Pathogenicity · Pathogenic for man and white mice. Causes a highly fatal pneumonitis in man.

Tissue tropisms: Infective in mice by the intranasal, intraperitoneal, intracerebral and subcutaneous routes.

Source Lungs of infected persons. Habitat: The etiological agent called

the Illinois virus (Zichis and Shaughnessy, Science, 102, 1945, 301).

## Genus III. Colesiota Rake, gen. nov.

(Rickettsia Coles, 17th Rept. Direct Vet Serv. and An Ind. Un. South Africa, 1931, 175.) Named for Prof. Coles who first studied these organisms.

Pleomorphic cells which may be coccoid, triangular, rod-shaped or in the form of rings. Gram-negative. Intracytoplasmic habitat

The type species is Colesiota conjunctivae (Coles) Rake

 Colesiota conjunctivae (Coles) Itake, comb. nor. (Rich ettaia conjunctiror Coles, 17th Rept. Direct. Vet. Serv and An Ind Un South Africa, 1931, 175; Chlamy Isroon conjunctivae Moshkovsky, Uspekhi Souremennoi Biologii, 19, 1915, 19) From M. L. conjunctiva, the conjunctiva.

Pleomorphic bodies: Average diameter 600 to 930 millimierons. May be solid and coccoid, rod shaped, or triangular, or in form of open rings or borse-shoes No chains. Masses frequent. No capsule. Stams with ordinary aniline dyes but less intensely than bacteria. Gramnegative. Non motile.

Cultivation: Has never been cultirated.

Immunological aspects: Unknown.

Pathogonicity: Pathogenic for sheep, cattle and goats. Causes acute conjunctivitis and keratitis.

Tiesus tropisms: Affects only the conjunctiva and cornea.

Potato: Thick, pale vellow becoming dark brown laver, slimy. The medium becomes bluish-gray.

Indole not formed.

Nitrates not produced from nitrates Acrobic, facultative

Ontimum temperature 37°C.

Pathogenic for mice.

Source: Regarded by Jaeger as the cause of Weil's disease (infectious jaundice) as it was found repeatedly in patients suffering from this disease. See Leniosnira icterohaemorrhagiae

Habitat. Water.

3. Pseudomonas fluorescens Migula. (Bacillus fluorescens liquefaciens Flugge, Die Mikroorganismen, 1886, 289, Migula, in Engler and Prantl, Die naturl. Pflanzenfamilien, 1, 1a, 1895, 29; Bacterium fluorescens Lehmann and Neumann, Bakt Diag., 1 Aufl , 2, 1896, 272 ) From Latin, fluor, flowing; M L fluoresco, to fluoresce

Rods: 0 3 to 0.5 by 1 0 to 1.8 microns, occurring singly and in pairs Motile, possessing a polar flagellum. Gram-

negative.

Gelatin colonies Circular, with greenish center, lobular, liquefying quickly. Gelatin stab Infundibuliform liquefaction, with whitish to reddish-gray sediment.

Agar slant. Abundant, reddish layer, becoming reddish-gray The medium shows greenish to olive-brown coloration

Broth . Turbid, flocculent, with yellowish green pellicle and grayish sediment. Litmus milk: No coagulation; becoming alkaline.

Potato · Thick, grayish-yellow, spreading, becoming light sepia-brown in color. Indole is not formed

Nitrates reduced to nitrates and ammonia.

Acid from glucose Blood serum liquefied.

Aerobic

Optimum temperature 20° to 25°C. Not pathogenic.

Source: Water, sewage, feces

Habitat: Soil and water.

4. Pseudomonas viscosa (Frankland and Frankland) Migula. (Bacillus viscosus G. and P. Frankland, Ztschr. f. Hyg , 6, 1889, 391; Migula, Syst. d. Bakt... 2, 1900, 900.) From M. L. viscidus, sticky, viscid.

Small rods: 0.5 by 1.5 to 2.0 microns, occurring singly. Motile and presumably polar flagellate. Gram-negative. Gelatin colonies: Gravish, granular,

with fimbriate margin. Medium assumes a green fluorescent color around each -vaolon

Gelatin stab: Infundibuliform liquefaction. Liquefied portion green fluorescent with greenish-white pellicle.

Agar slant: Thin, greenish-white, the medium becoming greenish.

Broth Turbid, with greenish pellicle. Litmus milk: Not coagulated.

Potato · Moist, chocolate-brown, viscid. Indole not formed.

Nitrites not produced from nitrates. Destroys nitrate with the production of ammonia.

Aerobic, facultative.

Distinctive characters: Resembles Pseudomonas fluorescens except that growth on agar, gelatin and potato is

Optimum temperature 20°C.

Source: Unfiltered water from Kent. England, Common

Habitat: Water

5 Pseudomonas fairmountensis (Wright) Chester. (Bacıllus fairmountensis Wright, Memoirs Nat. Acad. Sci., 7, 1895, 458; Chester, Man. Determ. Bact., 1901, 311; Achromobacter fairmountense Bergey et al , Manual, 1st ed., 1923, 146.) From M. L. of Fairmount Park (Philadelphia.)

Medium-sized rods, occurring singly, in pairs and in chains. Motile, possessing polar flagella. Gram-negative.

Gelatin colonies Circular, white, translucent. Dark centers with a greenish shimmer, thinner edges and faint radial lines.

Gelatin stab: Crateriform liquefaction.

Appendix to Order Rickettstales: The following are described species of intracytoplasmic and intranuclear parasites of Protozoa whose relationships to similar parasites of arthropods and vertebrates are not yet clear. All of the protozoa intracellular parasites are of larger size than typical members of Rickettstales and some have been placed in genera (Cladathriz, Micrococcus) where the typical species do not live intracellularly.

Genus A Caryococcus Dangeard.

(Compt rend. Acad. Sci , Paris, 154, 1902, 1365.)

Genus established for a bacterial parasite of the nucleus of Euglena; organisms rounded.

The type species is Caryococcus hypertrophicus Dangeard.

- Caryococcus hypertrophicus Dangeard. (Compt rend Acad. Sci., Paris, 184, 1902, 1365.) Parasitic in the nuclcus of a flagellate (Euglena deses).
- Occurs in the nucleus as an agglomeration of close-set, rounded corpuscles. The nucleus increases considerably in volume, the chromatin is reduced to thin layers against the membrane, the interior of the nucleus is divided into irregular compartments by chromatic trabeculae.
  - 2 Caryococcus cretus Kirby (Univ. Cahif Publ. Zool, 49, 1944, 210) Parasitic in the nucleus of a flagellate (Trichonympha corbula) from the intestine of a termite (Procryptotermes sp.), Madanascar

Spherules 1 to 15 microns or more in diameter, in preparations appearing clear with usually a chromatic, sharply defined, crescentic structure peripherally or interiorly situated, sometimes with two such bodies or several chromatic granules, praisitic in nucleus; prinsiized nucleus enlarged only moderately or not at all, chromatin altered but not greatly diminished in amount.

3 Caryococcus dilatator Kirby (Univ Calif Publ Zool., 49, 1941, 233) Parasitic in the nucleus of flagellates (Trickonymphackations and other species of Trickonympha) from the intestine of termites (Glyptotermes iridipennis), Australia, and other species

Spherules 05 micron or less in diameter, internally differentiated with stanable granule or stainable region peripherally situated; parasitic in nucleus and nucleous, nucleus becomes greatly enlarged and the e-homatin mostly or entirely disappears.

 Caryococcus Invadens Kirby. (Univ. Calif Publ Zool., 49, 1914, 238.)
 Parasitic in the nucleus of a flagellate (Trichonympha peplophora) from the intestine of a termite (Neotermes howa), Madagyscar.

Spherules I to 15 microns in diameter, sometimes arranged in pairs, often internally differentiated with stamable central or peripheral granules or stained arras, praisite in the nucleous or endoseme and nucleus, parasitized nucleolus becoming greatly enlarged and crossed by trabeculae, eventually consumed; nucleus becoming moderately enlarged, but chromatin not disappearing thought of the property of the prope

5 Caryococcus nucleophagus Kirby, (Univ Calif Publ Zeol, 49, 1914, 236.) Parasitie in the nucleus of a flagellist of (Trichonympha corbula) from the intestine of termites (Procryptotermes 19.), Madagurear, and three species of Kolotermes (s. 1.) from Mudagurear.

Prepared by Prof. Harold Kirby, Jr., University of California, Berkeley, California, October, 1916.

Spherules with a diameter of about 0.5 micron, sometimes arranged in pairs, sometimes with a thicker, crescentic, stainable area of the periphery on one side; parasitic within the nucleus, ex-

terior or interior to the chromatin mass, which may be diminished in amount, but does not disappear, nor is the parasitized nucleus appreciably enlarged.

# Genus B. Drepanospira Petschenko.

(Arch. f. Protistenk., 22, 1911, 282.)

Cell incurved in two spiral turns that are not abrupt, one of the ends pointed, the other a little rounded, no flagella, movement belicoid by means of all the body, no cell division, endospores formed, regular spherical colonies formed by individuals at certain stages of development.

The type species is Drepanospira mülleri Petschenko.

1. Drepanospira millieri Petschenko. (Mullerina paramecti Petschenko, Cent. f. Bakt, I Abt., Orig., 65, 1910, 90; Petschenko, Arch f Protistenk, 22, 1911, 252; see also Kirby, in Calkins and Summers, Protozoa in Biological Research, 1941, 1036) Parassitic in the cytoplasm of Paramecium caudatum.

Developing from a group of curved rods in the cytoplasm to a large, ellipsoidal mass almost filling the body. Nuclear portion occupying part of the cell.

The author regards this genus as belonging in the family Spirillocrae between Spirosoma and Microspira.

Genus C. Holospora Haffkine.

(Ann. Inst. Past , 4, 1890, 151.)

Genus established for bacterial parasites of the ciliate, Paramecium aurelia (\*\* Paramecium caudatum f).

The type species is Holospora undulata Haffkine.

1. Holospora undulata Haffkine (Ann. Inst. Past, Paris, 4, 1890, 151.) In the micronucleus of the ciliate Paramecium aurelia (= P. caudatumt).

Gradually tapered at ends; 13, 2 and 23 spiral turns; develops from a small usiform body which grows and divides transversely, brings about a great enlargement of the micronucleus, which becomes filled with the spirals (see Drepanospira multer: Petschenko).

 Holospora elegans Hafikine. (Hafi kine, Ann. Inst Past., Paris, 4, 1890, 164, see also Kriby, in Calkins and Summers, Protozoa in Biological Research, New York, 1941, 1035) In the micronucleus of the ciliate, Paramecium aurelia (e-P. caudatum?). Vegetative stage fusiform; elongated, elliptical, nucleus-like body in some; divides equatorially, budding at one end; transformation into spore entails ealargement, clear space separating membrane at sides, spore pointed at ends.

3 Holospora obtusa Hafikin (Hafikine, Ann. Inst. Past., Paris, 4, 1894) 153; also see Fiverskajia, Arch. f. Protistenk., 65, 1929, 276.) In the macronucleus of the clinate Paramecium aurelta (= P. caudalum f).

Spores not spiralled and both ends are numded. Reproduction by fission, ulso y formation of a bud at one of the extremities of the fusiform cell. Bodies with rounded ends 12 to 30 microus loop; also spindle-shaped bodies with pointed

ends, 05 by 3 to 6 microns (Fiveiskaja, loc cit ).

The following species have been placed in genera belonging in the orders Chlamydobacteriales and Eubacteriales respectively

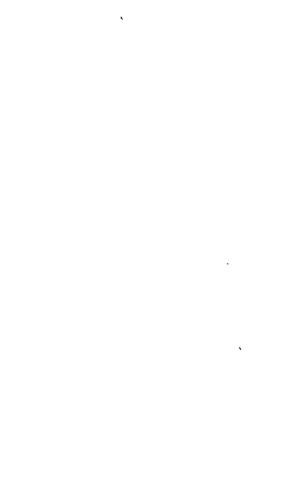
Cladoftift pelomyxae Veley (Veley, Jour Lann See, Zool, 29, 1905, 375; see also Leiner, Yeb I. Protistenk, 47 1921, 823, Kirby, in Calkins and Summers, Protora in Biological Research, New York, 1911, 1035; Hollande, Bull liul. I rance Belg, 79, 1915, 49). In the cytoplasm of the rhitopod, Pelomyxa polustris and probably also other species of Pelomyxa.

Rods, 15 to 22 microns or more in length, divided into several to many sections by transverse partitions, generally aggregated in proximity to the nuclei, which may be thickly invested by close-set bacteria applied to the surface

Micrococcus batrochorum (sec) Yakimoff (Arch f. Profistenk, 72, 1930, 137) In the cytoplasm of the flagellate, Trichomonas batrochorum from the tree toad (Hyla arborca). Also seen free in preparations of the intestinal contents of Hyla

Round, 1 to 15 microns in diameter, grouped generally in aggregates of irregular form, but also occur individually

Note. Further descriptions of bacterial and other parasites of Protozo with hubbiography will be found in Calkins and Summers, Protozoa in Biological Research, New York, 1911, 1009-1113 and in kirthy, Univ of Calif. Pub in Zailogs, \$4, 1916, 193-207.



## SUPPLEMENT NO. 2

# ORDER VIRALES THE FILTERABLE VIRUSES

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#### FILTERABLE VIRUSES\*

The so-called filterable viruses, today generally called merely viruses, are still of unknown affiliations so far as relationships to established groups of microorganisms are concerned. They are treated here as members of an order, consisting of 13 families, 32 genera and 248 species.

Among viruses as we know them, there are three constituent groups that have come to be recognized, and to some extent named and classified, through the largely separate efforts of bacteriologists, animal pathologists, and plant pathologists. Taxonomic overlapping of the three groups, viruses affecting bacteria, viruses having only animal hosts, and viruses invading higher plants, can hardly be justified as yet by available evidence. Nevertheless it has been shown that a single virus may multiply both in a plant host and in an insect vector. This seems to dispose of the thought that adaptation to a plant or animal environment would necessarily preclude utilization of other sources of the materials needed for multiblication.

For the present it seems feasible to continue with the custom, tacitly accepted in the past, of classifying bacteriophages separately as one sub-group, viruses causing diseases in seed plants as a second sub-group, and those causing diseases in seed plants as a send sub-group. It should be recognized that this may prove to be only a temporary arrangement, necessary because we have no evidence to warrant taxonomic overlapping of the three groups and useful while we await critical investigations and possible development of a substitute plan capable of displaying natural relationships to better advantage Eventually evidence may become available to show that some bacteriophages can infect higher plants or animals and can increase in the new environment, or that viruses known to attack animals or plants can similarly enlarge their host ranges. Or, there may be discoveries of common physical properties that would aid in formulating an interlocking classification, for which at present we lack any substantial basis.

It is of especial significance now that the three fields be unified at least by a parallel development of nomenclature. Toward this end the present section of this supplement is directed.

<sup>\*</sup> Supplement No. 2 has been prepared by Francis O. Holmes, The Rockefeller Institute for Medical Research, Princeton, N. J., September, 1944. In this section, suthorities for the names of plant hosts are in general as given by Gray's New Manual of Botany, 7th edition, and Beiley's Manual of Cultivated Plants, 1938, in each of these standard works will be found a list of abbreviations customarily used in botany in citing suthorities for binomasks.

# ORDER VIRALES Breed, Murray and Hitchens.

(Jour. Bact., 47, 1944, 421.)

Viruses Etiological agents of disease, typically of small size and capable of passing filters that retain hacteria, increasing only in the presence of living cells, giving rise to new strains by mutation, not arising denote. A considerable number of viruses have not been proved filterable; it is nevertheless customary to include these viruses with those known to be filterable, because of similarities in other attributes and in the diseases induced. Some not known to be filterable are inoculable only by special techniques, as by grafting or by use of insect vectors, and suitable methods for testing their filterability have not been developed; moreover, it is not certain that so simple a criterion as size measured in terms of filterability will prove to be an adequate indicator of the limits of the natural group. Cause diseases of bacteria, plants and animals.

Key to the suborders of order Virales.

I. Infecting bacteria.

Suborder I. Phagineae, p. 1128.

II. Infecting higher plants.

Suborder II. Phytophagincae p. 1145.

III. Infecting animals (insects, mammals).
Suborder III. Zoophagineae, p. 1225.

SUBORDER I. Phagineae subordo novus.

Viruses pathogenic in bacteria, bacteriophages. Containing at present only one family, the Phagaceae

#### FAMILY I. PHAGACEAE HOLMES.

(Handb, Phytopath. Viruses, \* 1939, 1.)

Characters those of the suborder. There is a single genus

# Genus I Phagus Holmes

(Loc. cit., 1.)

Characters those of the family. Generic name from Greek phagein, to eat.

The type species is Phagus menamus Holmes

NOTE: Bacterophagum d'Herelle (Compt rend. Soc. Biol., Pars, 81, 1918, 1161) a genus name applied in connection with early studies of bacteriophages, had as its type species Bacterophagum intestinale d'Herelle, a bacteriophage that is not now identifiable or, more probably, a mixture of such unidentifiable bacteriophages, for filtrates containing it were said to be capable of killing outright a culture of bacteria (tbid, 1160). The genus name Bactersophagum is, therefore, regarded as a nomen datum, if not also a nomen conjusum; subsequently it was abandoned by its author, for rensons that are not clear, in favor of the genus name Protobios d'Herelle 1924 (Immunity in natural infectious disease; page 343 of authorized English edition by George H. Smith, Baltimore, Williams & Wilkins Co., 1924, 393 pp). Protobios protobios

Holmes, F. O., Handbook of Phytopathogenic Viruses, Burgess Publishing Company, Minneapolis, Minn., 1939, 221 pp.

d'Herelle (loc cit ,345), presumably the type species of this genus, was not an ordinary virus but was said to be non-parasitic (ic, free-living) in mature, was capable of reducing sulphur, and is not now identifiable. The genus name Protobios and the corresponding binomial Protobios becterophagus d'Herelle are therefore regarded also as nomina dubic and are not used here. Bacterophagus Thornberry (Phytopath., 51, 1911, 23) appears to represent a variant spelling of d'Herelle's earlier genus name, it was not accompanied by any indication of what recognizable single bacteriophage served as type and thus does not modify the standing of Bacteriophagum.

- Ken to the species of genus Phagus.
- Dysentery-coli bacteriophages
  - A. Producing large plaques, 8 to 12 mm in diameter
    - 1. Particle size small, 8 to 12 millimserons.
      - 1 Phagus minimus
    - 2. Particle size 15 to 20 millumicrons.
      - Phagus minor.
  - B Producing moderately large plaques, 2 to 6 mm in diameter, with distinct halo.
    - 1 Particle size 20 to 30 millimicrons
      - 3 Phagus parius.
        - 4 Phagus primarius.
        - 5. Phagus secundarius.
          6 Phagus dysenteriae.
  - ( Plaques medium size, 1 to 3 mm in diameter, with distinct halo.
    - 1. Particle size 25 to 40 millimicrops.
      - 7 Phagus medius.
      - 8 Phagus astrictus.
  - D Plaques small, 0 5 to 1 5 mm in drameter, with soft edge or narrow halo
    - 1 Particle size 30 to 45 millimicrons.
      - 9 Phagus major. 10. Phagus cols.
      - 11 Phagus con.
  - E. Plaques very small, 0 1 to 1.2 mm in diameter, with sharp edges.
    - 1. Particle size 50 to 75 millimicrons
      - 12 Phagus maximus
- 11 Bacteriophages attacking Agrobacterium tumefaciens Conn, Pseudomanas solamacarum Emith, Xantlomonas citri Domon, Xanthorionas pruni Domon, Ericinia carotorora Holland, Ericinia aroideae Holland, Hacterium iteratri E F Fmith.

- A. Specific for bacterial hosts named above.
  - 13. Phagus tumoris.
    - 14. Phagus solanacearum.
    - 15. Phagus citri.
    - 16. Phagus pruni,
    - 17. Phagus deformans.
    - 18. Phagus contumax.
      19. Phagus maidis.
- III. Bacteriophages attacking Salmonella enteritidis Castellani and Chalmers.
  - 20. Phagus enteritides.
  - 21. Phagus commutabilis.
  - Phagus tertius.
     Phagus dubius.
- IV. Bacteriophage attacking Salmonella typhosa.
  - 24. Phanus indicens.
- V. Bacteriophages attacking Bacillus megatherium DeBary, Bacillus mycoides Flügge, and Rhizobium leguminosarum Frank.
  - A. Thermal inactivation at 75° C in 16 minutes in vitro.
    - Host may be freed from bacteriophage by heating at 80° C for 10 minutes.
      - 25. Phagus testabilis.
    - 2. Host retains virus even when heated at 90° C for 10 minutes.
      - 26. Phagus indomitus.
  - B. Thermal mactivation at 60° C in 30 minutes.
    - 27. Phagus subvertens.
- VI. Bacteriophages attacking streptococci.
  - 28. Phagus inepius.
  - 29. Phagus streptococci.
  - 30. Phagus maculans.
  - 31. Phagus lacerans.
  - 32. Phagus tolerans.
  - 33. Phagus michiganensis.
- VII. Bacteriophages attacking staphylococci.
  - 34. Phagus fragilis.
  - 35. Phagus intermedius.
  - 36. Phagus caducus.
  - 37. Phagus alpha.
  - 38. Phagus beta.

Agar slant: Grayish-white, glistening. Broth: Turbid.

Litmus milk: Alkalıne, litmus reduced Potato: Raised, granular, spreading, viscid

Indole is formed.

Nitrites not produced from nitrates Aerobic, facultative.

Optimum temperature 20° to 25°C.

Habitat: Water.

 Pseudomonas ureae Bergey et al (Culture No 3 of Rubentschick, Cent f. Bakt., II Abt., 72, 1927, 101; Bergey et al., Manual, 3rd ed., 1930, 173.)

Greek, urum, urine; M. L, urca, urea. Rods: 0.6 to 0.7 by 1.7 to 20 microns, occurring singly and in pairs Motile.

Gram-positive.

Gelatin stab: Infundibuliform lique-

Agar colonies · Circular, grayish-white. Agar slant; Grayish-white layer be-

coming greenish-fluorescent.

Broth: Turbid Litmus milk: Pentonized

Potato: Yellowish-brown streak Indole not formed

Nitrates reduced with gas formation

Ammonia formed.

Urea attacked. Hydrogen sulfide formed Methylene blue reduced Aerobic, facultative

Can grow at 0° C. Optimum temperature 20°C.

Optimum temperature 20°C. Habitat: Sewage filter beds

This species is included here through an oversight, It should have been placed in the Appendix to the genus Pseudomonas as the original description is too incomplete to determine its real nature. It is reported to be Grampositive and motile, but the number and arrangement of flagella are not given If it really is Gram-positive, the species is probably prefittedness and does not belong in Pseudomonas.

7. Pseudomonas pavonacea Levine and Soppeland. (Bul. No. 77, Iowa

State Agricultural College, 1926, 41.) From Latin, pavo, peacock

Rods 0 5 by 4.5 microns, with truncate ends, occurring singly and in chains. Motile Gram-negative.

Gelatin stab: Crateriform liquefaction. Medium becoming brown.

Agar colonies: Circular, raised, becom-

ing green, amorphous, entire.

Agar slant: Greenish, smooth, clisten-

ing, viscid, medium becoming slightly brown.

Broth Turbid, with viscid sediment.

Medium turned dark brown.

Litmus milk Slightly alkaline. Latmus reduced. Peptonized after 10 days.

Potato · No growth.

Indole not formed.
Nitrites not produced from nitrates.

Starch not hydrolyzed.

Blood serum liquefied in 5 days.

No acid or gas from carbohydrate media.

Acrobic, facultative.

Optimum temperature 22°C.

Source: Isolated from activated sludge

8 Pseudomonas effusa Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f Bakt, II Abt., 99, 1913, 515; also Soil Science, I, 1916, 472; Celtulomonas effusu Bergey et al., Manual, 1st ed., 1923, 192, Bacillus effusus appears first as a synonym in Bergey at al., bud; later used as name of species Sthed, 1939, 616) From Latin, effusus, cffuse, spread out

Rods. 0.4 by 17 microns. Motile with one to three polar flagella. Gramnegative.

Gelatin stab. Liquelaction.

Agar slant. Luxuriant, glistening, moist, ereamy growth Greenish fluorescence.

Peptone starch agar slant: Abundant, flat, moist rich creamy growth. Medium shows greenish fluorescence

Broth Turbid.

Litmus milk: Alkaline Congulation and digestion. tralized by sera specific for bacteriophages S13, C13, C36, D5, D20, D13, C18, D3, S8, C21, or C16.

Immunological relationships: Member of Smooth Dysentery Resistance Group. Other properties: Particle size, 30 to

45 millimicrons.

Literature: Burnet, Jour. Path. and Bact., 36, 1933, 307-318.

12. Phagus maximus H. (loc. cit., 147). From Latin maximus, greatest, in reference to particle size.

Common names: Bacteriophage C16, C4, C15, C20, C32, C46, D4, D12, D29, D53, H. J. K. and W. L. L.

Hosts: Escherichia coli Castellani and Chalmers; Shigella dysenteriae Castellani and Chalmers.

Induced disease. Small plaques, 0.1 to 1.2 mm in diameter, with sharp edges.

Serological relationships: No crossneutralization reaction with bacteriophages S13, C13, C36, D5, D20, D12, C18, D3, S8, C21, D6, or staphylococcus bacteriophage Au2 Agglutinated and inactivated by homologous, though not by other, antisera. For agglutination an original titer of 2 × 10° or higher is required; the reaction is visible to the unaided eye after 21 hours at 50° C and auceceds even after inactivation by heat (70 to 85° C for 30 minutes), formaldehyde, or a photodynamic dye (proflavine)

Immunological relationships; Member of Resistance Group II

Thermal inactivation: At or below 70° to 85° C for 30 minutes

Other proporties: Particle size estimated by filtration as 50 to 75 millimicrons, by centrifuging as 79 to 90 millimicrons, from photographs as 50 to 60 millimicrons Rapidly inactivated by 26.3 per cent urea solution Little or no inactivation by 1:25,000 methylene blue in 2 mm layer 20 cm from 100 candle-power light for 30 minutes Lysis not inhibited by 1.5 per cent or weaker solutions of sodium citrate Thermolabile

specific soluble substance formed in lysed cultures blocks phage antiphage reaction.

Literature: Burnet, Brit. Jour. Exp. Path., 14, 1933, 93-100, 100-108, 302-308, Jour. Path. and Bact., 55, 1933, 307-308, 57, 1933, 179-184; Burnet and Lush, ibid., 40, 1935, 455-460; Burnet and McKie, ibid., 58, 1933, 299-306.

13. Phagus tumoris H. (loc. cit., 150). From Latin tumor, a swelling, in reference to association of this bacteriophage with bacterial tumors.

Common name: Agrobacterium tumefaciens bacteriophace.

Host: Agrobacterium tumefaciens Conn.

Insusceptible species: Some strains of Agrobacterium tumefaciens, Bacterum stewarti E. F. Smith, Erwinna atroseptica Bergey et al., E. carolocora Holland, Pseudomonas tabaci Stapp, Xanthomonas beticola Burkholder, X. campestris Dowson, X. citri Dowson, X. phaseoli Dowson, X. pruni Dowson and X. resiculora Dowson and X. resiculora

Geographical distribution: United States, Russia.

Induced disease: Plaques 2 to 6 mm in diameter in 4 to 6 hours, edges of plaques spotted, moth-eaten in appearance until 40 hours after seeding; enlargement then stops and the edges of the plaques become smooth, double-ringer. Infection of plants by Agrobacterum tumcfacture is progressively inhibited by increasing amounts of bacteriophage in inoculum.

Thermal inactivation: At 95° C in 10 minutes (another report says 70° C, time not recorded).

Other properties: Resists dilution to 1:10<sup>11</sup>, storage at 5° C for over 25 montls, prompt, though not gradual, dyring; 1 per cent hydrogen peroxide for 72 hours; 95 per cent ethyl alcohol for 1 hour; 70 per cent ethyl alcohol for 6 hours; 21 per cent ethyl alcohol for 6 hours; 22 per cent ethyl alcohol for 6 hours; 21 per cent ethyl alcohol for 6 hours; 1:3000 nitric and for 1 hour; N/64 sodium hydroxide for 1 hour; N/64 sodium hydroxide for 1 hour.

Literature - Israilsky, Cent. f. Bakt,

- 39. Phagus durabilis.
- 40. Phagus liber.

#### VIII. Bacteriophages attacking vibrios.

- 41. Phagus cholerae.
- 42. Phagus celer.
- 43. Phagus effrenus.
  44. Phagus lentus.
- IX. Bacteriophages attacking Corynebacterium diphtheriae Lehmann and Neu-

# Bacteriophages attacking Coryntoacterium aiphiheriae Lehmann and Acmann.

- 45. Phagus diphtheriae.
- 46. Phagus futilis.
- Phagus minimus Holmes (Handb Phytopath Viruses, 1939, 141.) From Latin minimus, least, in reference to size Common name. Bacteriophage S13

Hosts · Escherichia coli Castellani sud Chalmers; Shigella dysenteriae Castellani and Chalmers.

Induced disease On plate cultures that are uniformly covered with confluent colonies of host organisms, this bacteriophage produces large cleared plaques, 8 to 12 mm in diameter, with wide shelving edges.

Serological relationships. No crossneutralization reactions with bacteriophages Cl3, C36, D5, D20, C18, D3, S8, C21, C16, and D6

Immunological relationships: Member of Resistance Group I

Other properties: Particle size 8 to 12 millimizerons. Not affected by 20 3 per cent urea solution. Little or no inactivation by 1 25,000 methylene blue in 2 mm layer 20 cm from 100 candle-power light for 30 minutes. Lysis completely inhibited by 0.25 per cent solution of sodium citrate.

Literature. Burnet and McKie, Jour Path and Bact., 58, 1933, 299-306, 307-318, 57, 1933, 179-184; Burnet et al, Austral Jour Exp. Bol and Med Sci, 18, 1937, 227-368.

2 Phagus minor II. (loc. cst., 141) From Latin minor, lewer. Common names: Bacterrophage C13, C8, and D44

Hosts: Escherichia coli Castellani and Chalmers, Shigella dysenteriae Castellani and Chalmers.

Induced disease: Large plaques, 8 to 12 mm in diameter, with wide shelving edges.

edges.

Serological relationships: Cross reactions with bacteriophages C8 and D14 but not with bacteriophages 513, C36, D5,

D20, D13, C18, D3, S8, C21, C16, D6 Immunological relationships: Member of Resistance Group I.

Other properties Particle size, 15 to 20 millimerous Completely inactivated by 1 '25,000 methylene blue in 2 mm layer 20 cm from 100 candle-power light for 30 minutes Specific soluble substance formed in lysed cultures blocks phage-

antiphage reaction.
Literature: Burnet, Jour. Path. and
Bact, 56, 1933, 307-318, Brit. Jour. Exp.
Path. 14, 1933, 109-108.

3 Phagus parvus II. (loc. cit, 142). From Latin parrus, small.

Common names - Bacteriophage C36, S18, C38, M, and C37 of Burnet.

Hosta Escherichia coli Castellani and Chalmera; Shigella dysenteriae Castellani and Chalmera.

Induced disease. Moderately large plaques, 2 to 6 mm in diameter, with distinct halo. 18. Phagus contumax spec. nov. From Latin contumax, refractory, in reference to ability of this bacteriophage to withstand heating sufficient to destroy accompanying host cells.

Common name: Erwinia aroideae bacteriophage.

Host : Erwinia aroideae Holland.

Insusceptible species: Agrobacterium tumefaciens Conn, Bacterium formosanum Chabe, Erunna carotoora Holland, Pseudomonas andropagoni Stapp, P. solanaccorum Smith, P. tomato Burkholder, Kanthomonas campetists Dowson, X. citri Dowson, X. makatae Dowson, X. phasecli Dowson, X. reinneda Dowson, X. reinneda Dowson, X. reinneda Dowson, X. reinneda Dowson, X.

Geographical distribution: Formosa (Taiwan)

Induced disease Very small plaques, 0.1 to 10 mm (mostly less than 0.5 mm) in diameter.

Thermal inactivation: Resists benting at 60° C for 30 minutes without appreciable loss of titer, but host organism is killed by this treatment.

Other properties. Optimum temperature for increase, about 25° C. This bacteriophage may be prepared by heating centrifuged cultures at 60° C for 30 miautes as efficiently as by filtration to remove bacteria.

Literature: Matsumoto, Trans. Nat Hist. Soc Formosa, 29, 1939, 317-338, 50, 1940, 89-98; 31, 1941, 145-154, Matsumoto and Sawada, 1bid, 23, 1938, 247-256

19. Phagus maidis H. (loc. cit., 152) From New Latin mais, corn (maire), host of Bacterium stewarti.

Common name Bacterium stewarts bacteriophage; Phytomonas stewarti bacteriophage; Aplanobacter stewarti bacteriophage.

Host: Bacterson stewarts E. F. Smith (= Pseudomonas stewarts E. F. Smith, Phytomonas stewarts Bergey et al. and Aplanobacter stewarts McCulloch).

Geographical distribution: United States Induced disease: In Bacterium steucarti, variation or loss of yellow color, change of viscosity of growth, reduction or loss of virulence. Infection of coraplants by seed-borne Bacterium setwarti is much reduced by treating seeds with this bacteriophage before they are planted.

Thermal inactivation: Above 65° C in 30 minutes. Other properties: Infective in dilu-

Other properties: Infective in dilutions to 10<sup>-7</sup>. Soon lost from cultures maintained at pH 3.85 to 400, or on Ivanoff's medium, which contains exidiring compounds.

Literature: Thomas, Phytopath, \$5, 1935, 371-372; Science, 88, 1938, 56-57; Phytopath., \$0, 1940, 602-611.

 Phagus enteritidis H. (loc. cd., 153). From name of host.

Common names: Salmonella entertidos bacteriophage 1, 12, or 33; Group A bacteriophages.

Hosts: Salmonella entertitus Castellani and Chalmers, S. gallinarum Bergey et al., Skigella dysenteriae Castellani and Chalmers.

Induced disease. Plaques of medium size, usually with surrounding translucent halo.

Immunological relationships: Member of Resistance Group A; host izalividuals that have acquired visitance to this bacteriophage are resistant to lines 12 and 33, but susceptible to Salmonedial entertiibs bacteriophages 8, 20, and 11, as well as to other strains of Resistance Groups B, C, and D

Literature: Burnet, Jour. Path. and Bact., 53, 1929, 15-42

21. Phagus commutabilis H. (loc. cit, 153). From Latin commutabilis, variable, in reference to differences within Resistance Group B, typified by this beteriophage.

Common names: Salmonella enteritudis bacteriophage 8, 18, 28, 31, 34, 38; Group B bacteriophages.

Hosts : Salmonella enterstidis Castellani

11 Abt., 67, 1926, 236-242; 71, 1927, 302-311, 79, 1929, 354-370; Kent, Phytopath., 27, 1937, 871-902; Muncie and Patel, Phytopath., 20, 1930, 289-305.

14 Phagus solanacearum II (loc cit., From name of host. 118)

Common name: Pseudomonas solanacearum bacteriophage.

Pseudomonas solanacearum Host Smith.

Geographical distribution: Formosa (Taiwan)

Induced disease · Medium size plaques on plate cultures of Pseudomonas solanacearum

Serological relationships: When innected into rabbits, this bacteriophage stimulates the production of a specific precipitating antibody not giving cross reactions with anti-bacterial antibodies. Antiphagic serum inactivated at 90° C in 10 minutes

Thermal mactivation; At 63° C in 10 minutes (61° C in 30 minutes; 66° C in

about 1 minute) Other properties: Optimum tempera-

ture for increase, 31° C Laterature Matsumoto and Okabe. Jour Plant Prot , 22, 1935, 15-20, Jour. Soc. Trop. Agr., 7, 1935, 130-139, 9, 1937, 205-213

15 Phagus citri II (loc. cit., 149) I'rom name of host

Common name Xanthomonas citri bacteriophage

Host Vanthomonas citrs Dowson, the curus canker organism

Geographical distribution: Formosa (Taiwan)

Induced disease Lasis This bacterrophage has been isolated from soil under diseased trees, and once from infected leaves. It may play a role in the destruction of the citrus canker organism in the soil.

Other properties: Optimum temperature for increase, 30° C

Literature Matsumoto and Okabe,

Agriculture and Horticulture, 12, 1937, 2055-2059.

16. Phagus prunt H. (loc. cit., 151). From name of host.

Common name: Xanthomonas pruni bacteriophage.

Host: Xanthomonas prunt Dowson.

Geographical distribution: United States (from soil beneath infected peach

trees). Induced disease: Lysis in broth cultures; plaques on agar cultures, but characteristics of plaques not described.

Other properties: Estimated diameter 11 millimicrons in broth Resists dilution to 1:10 or more.

Literature. Anderson, Phytopath., 18, 1928, 144; Thornberry, sbid., 25, 1935. 938-946.

17. Phagus deformans II. (loc. cit., 151). From Latin deformare, to disfigure, in reference to malformation of infected host cells.

Common name Erunnia carolotora Incteriophage.

Host · Ericinia carolotora Holland Insusceptible species · Agrobactersum

tumefactens Conn, except in some early tests with possibly mixed bacteriophages: Erwinia amylorora Winslow et al., E. melonis Holland, Salmonella pullorum Bergery et al., S gallingrum Bergey et al , Shigella dysenteriae Castellani and Chalmers, Xanthomonas pruni Dowson

Geographical distribution. United States (Michigan).

Induced disease: In Erwinia carotorors, cells reduced in motility, agglutinsted, malformed, some elongated. others swollen, bulged at one end, bulged in middle, or enlarged and spherical,

Other properties. Resists dilution to 1.10', and storage in sterile medium at room temperature for 5j months,

Literature: Coons and Kotila, Phytopath , 15, 1925, 357-370; Mallmann and Hemstreet, Jour. Agr. Res , 28, 1921, 309-602.

25. Phagus testabilis II. (loc. cit., 155). From Latin testabilis, able to bear witness, in reference to evidence that this bacteriophage has given, by virtue of its easy destruction when heated in spores. against the hypothesis of frequent snontaneous origin of bacteriophage from the bacterial host.

Common name: Bacillus megatherium bacteriophage.

Host: Bacillus megathersum De Bary. Geographical distribution: United States.

Induced disease : Plaques 0.5 mm or less in diameter, with surrounding translucent zone.

Thermal inactivation: In vitro, at 75° C in 10 minutes. Spores from infected cultures, after being heated for 10 minutes at 80° C. regularly give rise to subcultures that do not show the presence of this bacteriophage spontaneously during subsequent growth but that are susceptible to lysis if the bacteriophage is nenin introduced.

Literature: Adant, Compt. rend. Soc. Biol., Paris, 99, 1928, 1246; Cowles, Jour. Bact., 20, 1930, 15-23.

26, Phagus Indomltus II. (loc. cil., 156). From Latin indomitus, unrestrained, in reference to the ability of this bacteriophage to increase after heat treatment of infected spores.

Common name : Bacillus mycoides bacteriophage.

Host: Bacillus mycordes Flügge, some

strains

Insusceptible species: Bacillus cereus Frankland and Frankland, B. subtilis Cohn emend. Prazmowski, B. megatherium De Bary, B. anthracis Cohn emend, Koch. Some strains of B. mycoides.

Geographical distribution. United States.

Induced disease: Large plaques, with some secondary growth of host organism.

Thermal inactivation : In vitro, at 75° C in 10 minutes. Spores from infected cultures, heated at 90° C for 10 minutes give no bacteriophage on grinding, but lytic cultures when grown.

Literature: Lewis and Worley, Jour. Bact., 52, 1936, 195-198.

27. Phagus subvertens II. (loc. cit. 156). From Latin subvertere, to subvert, in reference to suspected action of this bacteriophage in causing running-out of alfalfa fields through destruction of nodule organisms.

Common name: Rhizobium leguminosarum bacteriophage.

Rhizobium leguminosarum Host: Frank. It has been shown that this bacteriophage is unable to increase in clover roots without the nodule-forming organism, R. leguminosarum, and that the bacteriophage plays no obviously essential role in nodule formation.

Induced disease: Very small plaques, with edges not sharply defined.

Thermal inactivation: At 60° C in 30 minutes.

Other properties: Not inactivated by drying for 2 months.

Literature: Gerretsen et al , Cent. f. Bakt., II Abt., 60, 1923, 311-316; Grijns, ibid., 71, 1927, 248-251; Hitchner, Jour. Bact., 19, 1930, 191-201; Vandecaveye and Katznelson, Jour. Bact., 51, 1936, 465-477.

28. Phagus Ineptus H. (loc. cil., 157). From Latin meptus, unsuitable, in reference to inability of this bacteriophage to adapt itself to lysis of strain RW of its host.

Common name : Streptococcus bacteriophage R.

Host: Streptococcus cremoris Orla-Jensen, strain R.

Insusceptible species: Streptococcus cremoris, strain RW.

Geographical distribution: New Zealand.

Induced disease: Plaques 0,25 to 06 mm in diameter.

Serological relationships: Antisera specific for streptococcus bacteriophage RW

and Chalmers, Shigella dysenteriae Castellani and Chalmers, Shigella gallinarum Weldin, Salmonella tuphosa White.

Induced disease: Small plaques with sharp edges, or moderately large plaques with characteristic halo.

Immunological relationships · Member of Resistance Group B, host individuals that have acquired resistance to this bacteriophage are resistant to lines 18, 28, 31, 31, and 38, but susceptible to Salmonella enteritidis bacteriophages 1, 20, and 11, as well as to other strains of Resistance Groups A, C, and D

Literature: Burnet, Jour. Path and Bact., 32, 1929, 15-42.

22. Phagus tertius II (loc cit, 151) From Latin tertius, third, in reference to the third Resistance Group of Salmonella enteritidis bacteriophages, Group C, typified by this bacteriophage.

Common names · Salmonella enteritidis bacteriophage 20, 25, 32, 35, Group C bacteriophages.

Hosta Salmonella enteritidis Castellani and Chalmers, S gallinarum Bergey et al , Shigella dysenteriae Castellani and Chalmers

Induced disease. Plaques of small size, with sharp edges.

Immunological relationships Member of Resistance Group C Host individuals that have acquired resistance to this bacteriophage are resistant to lines 25, 35, and 32, but susceptible to Salmonella enteritidis bacteriophages of Resistance Groups A, B, and D

Literature Burnet, Jour Path and Bact., 32, 1929, 15-12

23 Phagus dubius II (loc cit 155) From Latin dubius, doubtful, in reference to uncertainty of distinction between Resistance Groups C and D

Common names Salmonella enterstulis bacterophage 11, 13, Group D bacterio plages

Hostn Salmonella enteritidia Castellam and Chalmers, Shroella dysenteriae Castellani and Chalmers, Shigella gallinarum Weldin.

Induced disease: Very large plaques, up to 8 mm in diameter on 1.2 per cent agar

Immunological relationships: Member of Resistance Group D. Host individuals that have acquired resistance to this bacteriophage are resistant to line 13, but susceptible to Salmonella enteritidis bacteriophages of Resistance Groups A. B. and C.

Literature Burnet, Jour. Path. and Bact., 32, 1929, 15-42

24. Phagus indicens spec. nov. From Latin indicere, to disclose or indicate, in reference to diagnostic use of this bacteriophage in identifying V forms of the typhoid bacillus

Common name Phage Q151. Host: Salmonella typhosa White (= Bacillus typhosus Zopf).

Insusceptible species: W forms of the typhoid organism and various Salmonella

Geographical distribution . Canada.

species.

Induced disease In Salmonella typhosa. small plaque formation (lysis) and complete inhibition of growth in cultures of the V form (bearing Vi antigen; resisting O acclutination) and no lysis or restraining effect on growth of the W form (lacking Vi antigen, agglutinated by O anti-In the presence of the virus, mixed cultures are quickly transformed since only W variants can increase V cultures can be identified by the test for their complete inhibition, this inlabition is regularly followed by secondary growth representing the pure W form of the host, a readily formed variant

Filtershilty Passes Seitz EK filter

Other properties. Liltrates active in dilutions to 10" or 10".

Laterature: Craugie, Jour. Bact. 31. 1936, 56 (Abst.); Craige and Brandon. Jour Path and Bact., 43, 1936, 233-248. 219-260

bacteriophage to remain viable under certain adverse conditions.

Common name : Streptococcus bacteriophage C.

Hosts: Streptococcus 646, 594, 756, 806. Geographical distribution: United States (Ohio, Massachusetts, Connecticut).

Induced disease: Small plaques, the largest about 1.0 mm in diameter.

Serological relationships: Specific neutralization, but no cross reactions with streptococcus bacteriophages A, B, and D.

Thermal inactivation: At 63° to 65° C in I hour.

Other properties: Withstands storage in 1:200 phenol at about 5° C for at least 261 days; equally resistant to storage in 1:10,000 sodium ethyl mercurithiosalicy-late (merthiolate), or to storage without preservatives.

Laterature: Evans, U. S. Pub. Health Ser., Public Health Reports, 49, 1934, 1386-1491.

33. Phagus michiganensis spec. nov. From name of state, Michigan, where this bacteriophage was first soluted.

Common name : Streptococcus bacteriophage D.

Host : Streptococcus 693.

Geographical distribution: United States (Michigan)

Induced disease. Small plaques, about 0.75 mm in diameter, edges clear-cut, centers clean.

Serological relationships: Specific neutralization, but no cross neutralization with streptococcus bacteriophages A, B, and C.

Thermal inactivation, At 60° to 63° C in I hour.

Other properties: Withstands storage at about 5°C for at least 261 days.

Literature Evans, U. S Pub Health Ser., Public Health Reports, 49, 1934, 1386-1401.

Phagus fragilis, H (loc. cit, 159).
 From Latin fragilis, fragile, in reference

to easy destruction of this bacteriophage by light and by concentrated urea solutions.

Common names; Staphylococcus becteriophage Au2, Au3, Au4, or D, perhaps bacteriophage H of Gratia.

Hosts: Staphylococcus aureus Rosenbach and Staphylococcus albus Rosenbach Geographical distribution: Umted States.

Induced disease: Small plaques, 02 to 1.0 mm in diameter, with sharp edges

Scrological relationships: Cross-neutralization reactions with staphylococcus bacteriophages Aul, Au3, Au4, and D, but not with staphylococcus bacteriophages Au21, Au32, A, B, C, or bacteriophage Clf.

Thermal inactivation: At about 57° C in 30 minutes.

Other properties: Particle diameter 50 to 75 millimicrons. Readily inactivated photodynamically. Completely inactivated by 27 per cent urea solution in I hour at 37° C. Lysis not inhibited even by 15 per cent sodium entrate in sgar medium.

Literature: Burnet and Lush, Jour Path. and Bact., 40, 1935, 455-469; Burnet and McKie, Austral. Jour. Exp. Biol and Med. Sci., 6, 1929, 21-31; Tisk, Jour. Inf. Dis., 71, 1942, 153-160.

35. Phagus Intermedius II (loc. ct., 160). From Latin intermedius, intermedius, in referent to position of this bacteriophage between staphyloroccus bacteriophages that multiply readily in broth cultures of host organisms and those that do not.

Common name: Staphylococcus lucteriophage Au21.

Host: Staphylococcus aureus Rosenbach.

Geographical distribution: Australia.
Induced disease: Small plaques, 01 to

0.3 rum in diameter, with sharp edges. Scrological relationships: Specific neutralization reaction but no cross-neutralization reaction with staphylococcus bacteriophages Au2 or Au12. and its strain RW1 are ineffective in neutralizing this bacteriophage.

Immunological relationships: Cultures of bot-strain R, after exposure to this bacteriophage, furnish subcultures only partly resistant to this bacteriophage and completely susceptible to streptococcus bacteriophage RW and its substrain RWI.

Literature: Whitehead and Hunter, Jour. Path and Bact., 44, 1937, 337-347

Phagus streptococci II (loc cit,
 From generic name of host.

Common name Streptococcus bacteriopluage RW

Host Streptococcus cremoris Orla-Jensen, strain RW

Geographical distribution New Zealand

Induced disease Plaques 0.25 to 06 mm in diameter.

Thermal inactivation. At 70° to 75° C, time not recorded, probably 30 minutes (pH 60)

Laterature Whitehead and Hunter, Jour Path and Bact., 44, 1937, 337-347 Strains One variant has been described and distinguished from the type variety.

tunicus II (loc cit., 158)

- 29a Phagus streptococci var erritis II (toc ct. 158). From Latin rivitis, vigorous Common name: Stram RWI of streptococcus bacteriophage RW. Differing from the type variety in being able to increase at the expense of strum RWI of Streptococcus aremoris (Whitehead and Hunter, Jour Path and Bact., 44, 1937, 337-317)
- 30 Phagus maculans apec nor Prom Latin maculare, to speckle, in reference to tiny plaques produced by this bacteriophage

Common name Streptococcus bacteriophage A

Hosta Streptococcus 616, 751, 775
Geographical distribution United
States (Masachusetts)

Induced disease: Plaques exceedingly

minute, scarcely visible to the unaided eye.

Serological relationships: Specific antisera neutralize but there is no cross reaction with respect to streptococcus bacteriophare B. C. or D.

Thermal inactivation. At 60° C in 1

Other properties: Withstands storage at about 5° C for at least 145 days with but little loss of varulence.

Literature: Evans, Science, 80, 1931, 40-41; U.S.P.H.S., Public Health Reports, 49, 1934, 1386-1401

31 Phagus lacerans spec. nor. From Latin lacerare, to tear, in reference to ragged edges of plaques produced by this bacteriophage.

Common name: Streptococcus bacteriophage B

templage B
Hosts Streptococcus 563,639: Streptococcus mucosus Howard and Perkins.

Insusceptible species: Streptococcus erysipelatos Rosenbach.

Geographical distribution: United States (Wisconsin).

Induced disease Medium size plaques, the largest about 3 mm in diameter, edges ragged, centers clean.

Serological relationships: Specific neutralization, but no cross reactions with streptococcus bacteriophages A, C, and D.

Thermal inactivation: At 60° C in 1 hour Other properties. Withstands storage

at about 5° C for at least 261 days

Literature Clark and Clark, Jour. Bact, 11, 1920, 89; Proc. Soc. Exp. Biol. and Med. 24, 1927, 633-639; Colvin, Jour. Inf. Dus. 51, 1932, 17-29; Evans, U.S.P.H.S., Public Health Reports, 42, 1934, 1389-1401, Jour. Bact, 29, 1910, 207-601; Shwartman, Jour. Exp. Med. 4, 1927, 497-590

32 Phagus tolerans spec nor. From Latin tolerans, tolerating, in reference to the unusual ability of this streptococcus and McKie, Austral. Jour. Exp. Biol. and Med. Sci., 6, 1929, 21-31.

39. Phagus durabilis H. (loc. cit., 162). From Latin durabilis, lasting, in reference to the stability of this bacteriophage in concentrated urea solution and other unfavorable media.

Common name: Staphylococcus bacteriophage C,

Host: Staphylococcus albus Rosenbach. Geographical distribution: Australia. Induced disease: Plaques 2.0 to 3.0 mm in diameter. Vitreous change in pe-

ripheral zone.

Serological relationships: Cross-neutralization reaction with staphylococcus bacteriophage C', and less strongly with B, but not with Au2 or A.

Immunological relationships: Colonies of Staphylococcus albus appearing after lysis with this hacteriophage furnish organisms resistant to it but susceptible to staphylococcus bacteriophages A, B, and D.

Thermal inactivation · At 61° to 63° C in 30 minutes.

Other properties Not readily inactivated photodynamically; not completely inactivated by 27 per cent urea solution in 1 hour at 37° C; lysis not inhibited even by 1.5 per cent sodium citrate in agar medium.

Literature: Burnet and Lush, Jour. Path. and Bact., 40, 1935, 455-469; Burnet and McKie, Austral. Jour. Exp. Biol. and Med Sci., 6, 1929, 21-31; Rakieten et al., Jour. Bact, 52, 1936, 505-518.

40. Phagus liber H. (loc cit., 163). From Latin liber, independent, in reference to demonstrated independence this virus, its bacterial host, and its dipterous superhost, in respect to origin.

Common name · Staphylococcus muscae bacteriophage.

Host: Staphylococcus muscae Glaser. Geographical distribution: United States

Induced disease: Lysis in broth cul-

tures; plaques in agar cultures, but characteristics of plaques not recorded.

Thermal inactivation: At a little above

Other properties: A characteristic nucleoprotein has been isolated from lysed staphylococci. Sedimentation costant, 650 × 10<sup>-11</sup> cm dyne<sup>-1</sup> sec.<sup>-1</sup> corresponding to a molecular weight of about 300,000,000 Denatured at acidities beyond pH 5 0. Digested by chymotrypsin, not by trypsin. Apparent density, about 1.20. Diffusion coefficient, varying with dilution.

Literature: Glaser, Amer. Jour. Hygiene, 27, 1938, 311-315; Northrop, Jour. Gen. Physiol., 21, 1938, 335-366; Shope, Jour. Exp. Med., 45, 1927, 1037-1044, Wyckoff, Jour. Gen. Physiol., 21, 1938, 367-373.

41. Phagus cholerae H. (loc. cit., 164) From former name of host.

Common name: Vibrio commo hacteriophage.

Host: Vibrio comma Winslow et al (formerly V. cholerne Neisser); Indian strains usually carry this bacterioptage, but Chinese and Japanese strains lack it, are susceptible, and upon inoculation become Iysogenic.

Geographical distribution: India.

Induced disease: In both R and S forms of Vibrio comma, no plaques on ordinary ngar plates, but vibrios become lysogenio. Egg-white in 1:25 dilution enhances activity enough to allow visible lysis, occasional plaques, or stippling at the site of inoculation.

Immunological relationships. Vibra comma organisms that have been infected with this bacteriophage and are resistant to its further action are still susceptible to cholera bacteriophages A, C, and D.

Literature White, Jour. Path. and Bact., 44, 1937, 276-278

42. Phagus celer H. (loc. cit, 164). From Latin celer, quick, in reference to relatively quick action of this bacterio-phage.

Other properties: Not readily inactivated photodynamically; completely innetivated by 27 per cent urea solution in 1 hour at 37° C; lysis inhibited by 1 per cent sodium citrate in egar medium but not by 0.5 per cent or lower concentrations.

Literature: Burnet and Lush, Jour Path and Bact., 40, 1935, 455-469

36. Phagus caducus H. (loc cit, 160) Γrom Latin caducus, perishable, in reference to the easy destruction of this bacteriophage by concentrated urea solutions.

Common name: Staphylococcus bacteriophage Au12.

Host, Staphylococcus aureus Rosenbach

Geographical distribution - Australia Induced disease Small plaques, 0.2 to 0.5 mm in diameter, with sharp edges

Serological relationships: Cross-neutralization reactions with staphylococcus lacteriophages AuII and AuI3, but not with staphylococcus bacteriophages Au2, Au21, A, and C. Antiserum to staphylococcus bacteriophage B gives no neutralization of AuI2, though the reciprocal reaction occurs to 1 200 dulution.

Other properties. Not readily inactivated photodynamically, completely inactivated by 27 per cent urea solution in 1 hour at 37° C, lysis inhibited by as little as 0.25 per cent sodium citrale in agar. Literature Burnet and Lush, Jour

Path and Bact , 40, 1935, 455-469

37 Phagus alpha II (loc cit., 161) From Greek equivalent of common name Common name Staphylococcus tracteriophage A

Host Staphylococcus albus Rosenbach Geographical distribution. Australia Induced disease. Plaques of medium size, 1.5 to 2.5 mm in diameter, with hars periphers.

Serological relationships, Specific neutralization reaction, but no cross neutralization reactions with staphylococcus lacteriorilages Au2, B, or C

Immunological relationships: Colonies of Staphylococcus albus appearing after lysis with this bacteriophage are resistant to staphylococcus bacteriophages B, C, and D.

Thermal inactivation: At 68° to 70° C in 30 munutes.

Other properties: Not readily inactivated photodynamically; not completely mactivated by 27 per cent urea solution in 1 hour at 37° C, lysis not inhibited even by 1 5 per cent sodium citrate in agar.

Literature. Burnet and Lush, Jour. Path and Bact., 40, 1935, 455-469, Burnet and McKie, Austral. Jour. Exp. Biol. and Med Sci., 6, 1929, 21-31.

38. Phagus beta H. (loc. cit., 162).
From Greek equivalent of common name.
Common name. Staphylococcus bac-

teriophage B.
Host · Staphylococcus albus Rosenbach.

Geographical distribution: Australia. Induced disease Plaques of medium size, 07 to 15 mm in diameter, with

sharp edges

Serological relationships. Specific neutralization reaction, but no cross-neutralization reaction with respect to staphylococcus bacteriophages Au2, Au2, A, or C, except that antiserum made with Au12 neutralizes this bacteriophage in low didutions (See Phagus caducus).

Immunological relationships: Colonies appearing after lysis of Staphylococcus albus with this beteriophage furnish organisms susceptible to staphylococcus Exercisophages A and D

Thermal mactivation At 63° to 65° C in 10 minutes.

Other properties Readily inactivated photodynamically; completely inactivated by 27 per cent urea solution in 1 hour at 37 °C, lysis not inhibited even by 1.5 per cent sodium citrate in agar medium.

Literature Burnet and Lush, Jour. Path and Ract., 49, 1935, 455-469; Burnet Potato: Rich, creamy spreading growth.

Indole not formed.

Nitrites not produced from nitrates.

Ammonia is produced.

Acid from glucose, maltose, starch, glycerol and mannitol. No acid from lactose or sucrose.

Cellulose is attacked.

Acrobic, facultative.

Optimum temperature 20°C.

Source: Isolated from soils in Utah.

8a. Pseudomonas effusa var. non-liquefaciens Kellerman et al (loc. cit.). A non-liquefying variety that acts more slowly on litmus milk.

Source: Soils from Utah.

Pseudomonas reptilivorous Caldwell and Ryerson. (Jour. Bact., 39, 1940, 335.) From Latin, reptile, a reptile and voro, to devour, destroy.

Rods. 0 5 by 1 5 and 2 0 microns, occurring singly, in pairs and in short chains and having rounded ends Actively mottle with two to six polar flagella. Gram-negative

Gelatin colonies. After 24 hours, small, circular, smooth, entire. Liquefaction with a yellowish-green fluorescence.

Gelatin stab Infundibuliform liquefaction becoming stratiform. Putrid odor present.

Agar cultures: Circular, smooth, glistening, slightly raised, butyrous, translucent, 2 mm in diameter.

Agar slant: Growth abundant, smooth, filiform, glistening, butyrous and translucent.

Broth Turbid with pellicle and sediment. Putrid odor.

ment. Putrid odor. Litmus milk: Alkaline, peptonization,

complete reduction Disagreeable odor Potato. Growth moderate, spreading, glistening, yellowish-gray to creamy. Disagreeable odor Medium becomes brownish-gray.

Indole not formed.

Nitrates not produced from nitrates.

Hydrogen sulfide not produced.

Slightly acid, becoming alkaline in glucose. No acid from arabinose, xylose, lactose, sucrose, maltose, trehalose, raffinose, mannitol, dulcitol, inositol and solicin.

Starch not hydrolyzed.

Pathogenic for guinea pigs and rabbits, horned lizards, Gila monsters and chuckwallas.

Temperature relations: Optimum 20° to 25°C. Maximum 37°C.

Distinctive characters: Yellowishgreen fluorescence present in meat infusion media. Pathogenic.

Source: Isolated in a bacterial disease of horned lizards and Gila monsters. Habitat: Pathogenic for lizards.

Pseudomonas syncyanea (Ehrenberg) Migula. (Vibrio suncuancus Ehrenberg, Berichte u.d. Verh. d. k. Preuss. Akad d Wissensch. z. Berlin, 5, 1840, 202: Vibrio cyanogenes Fuchs, Magazin für die gesamte Tierheilkunde, 7, 1811, 190; Bacillus syncyaneus Schroeter, Kryptogam. Flora von Schlesien, 3, 1, 1886, 157; Bacillus cyanogenus Zopf, Die Spaltpilze, 3 Aufl., 1885, 86; Migula, in Engler and Prantl, Die natürl, Pflanzenfam., 1, 1a, 1895, 29, Bacterium syncyaneum Lehmann and Neumann, Bakt. Diag., I Aufl., 2, 1896, 275; Pseudomonas cyanogenes Holland, Jour. Bact., 5, 1920, 224) From Greek, syn, with; Luaneos, dark blue, dark,

Rods with rounded ends, occurring singly, occasionally in chains, 0.7 by 2.0 to 4.0 microns. Motile with two to four polar flagella. Gram-negative.

Gelatin colonies Flat, bluish, translucent.

Gelatin stab: Surface growth shiny, grayish blue. The medium is colored steel-blue with greenish fluorescence. Gelatin is liquefied. Some strains do not liquefy.

Agar slant: Grayish-white streak. The medium takes on a bluish-gray color with slight fluorescence. Common name: Cholera bacteriophage A.

Host. Vibrio comma Winslow et al , smooth types, except non-agglutinable vibrios.

Geographical distribution: India Induced disease, Lysis in 2 hours, fol-

Induced disease, 1978 in 2 hours, loilowed by abundant secondary growth Only smooth elements of the culture are attacked

Serological relationships Antigenically distinct from cholera bacteriophage C

Immunological relationships Secondary growth resistant to this virus, but susceptible to cholera bacterioplages C and D

Other properties Selectively inactivated by specific polyacecharide of smooth strains, not by a lipoid emulsion that is effective against cholera bacteriophage C. Active in dilution of 1 10° or 1 10° Multiplication rate, n. × 10° in 2 hours.

Literature Asheshov et al , Indian Jour Med Res , 20, 1933, 1127-1157, White, John Path and Bact , 45, 1930, 591-593

43 Phagus effrenus II. (loc cit, 165) From Latin effective, unbridled, in reference to the ability of this bacteriophage to attack all tested strains of the cholera greanism

Common name Cholera bacteriopliage C

Host · Vibrio comma Winslow et al , all

Geographical distribution India.

Induced discuse Sometimes death without lysis. When lysis occurs, it is rarely complete and is followed by secondary resistant growth.

Serological relationships Antigenically distinct from cholera inciterophage A

Immunological relationships Second ary growth resistant to this bacterio phage, but susceptible to cludera for terophages A and D

Other properties Selectively macts vated by lipsud from smooth strain of host, but not by specific polysaccharide Active in dilution of 1:10\* or 1:10\*
Multiplication rate, n × 10\* in 2 hours.

Literature: Asheshov et al., Indian Jour. Med. Res., 20, 1933, 1127-1157; White, Jour. Path. and Bact., 45, 1936, 591-593

44 Phagus tentus II. (loc. cit., 166) From Latin leatus, slow, in reference to the relatively slow and incomplete lysis induced by this bacteriophage.

Common name Cholera bacteriophage D.

Host · Vibrio comma Winslow et al

Geographical distribution: India Induced disesse Incomplete lysis in about 5 hours, followed, in rough cultures,

by slow development of resistant accordary growth
Immunological relationships Second-

ary growth resistant to this bacteriophage, but susceptible to cholera bacteriophages A and C.

Other properties Not inactivated by

specific rolysaccharide effective against cholera bacteriophage A, nor by lipoid effective against cholera bacteriophage C. Multiplication rate, n × 10<sup>3</sup> in 2 hours.

Literature Asheshov et al., Indian Jour Med. Res., 29, 1933, 1127-1157; White, Jour Path. and Bret., 43, 1936, 591-593.

45 Phagus diphtheriae II (loc cit., 167). From name of host

Common name Corynebacterium diph-

Host Conjudatorium diphtheriae Lehmann and Neumann, many strains, especially 122 of 127 Australian type II gravis isolates, type I gravis isolates are 15 mg nic (extricts), all intermediate loslates are succentible.

Insucceptible species Corynebacterium diptheriae, all tested miss inslates, except 2 lymponic A strain of C diphtheriae from Swan Hill, 200 miles north of Melbourne, was found to be resistant to this functionphage and to the small plaque diphtheria bacteriophage, P. futilis.

Geographical distribution: Australia. Induced disease: In Corynebacterium

diphtheriae on agar, plaques 1.0 to 1.5 mm in diameter, with shelving edge. A few resistant bacterial colonies often appear in the central clear area.

Literature: Keogh et al., Jour. Path. and Bact., 46, 1938, 565-570; Smith and Jordan, Jour. Bact., 21, 1931, 75-88; Stone and Hobby, Jour. Bact., 27, 1934, 403-417.

46. Phagus futilis H. (loc. c.t., 168). From Latin futilis, vain, in reference to regular appearance of resistant organisms in plaques on agar cultures lysed by this bacteriophage.

Common name: Small-plaque diphtheria bacteriophage.

Host: Corynebacterium diphtheriae Lehmann and Neumann, gravis type I isolates and all but 5 gravis type II isolates.

Insusceptible species: All tested intermediate and mitis strains of C. diphtheriae. Geographical distribution; Australia

Induced disease: In Corynebacterium diphtheriae on agar, pin-point plaques or confluent plaques, with confluent growth of secondary, resistant organisms.

Literature: Keogh et al., Jour. Path. and Bact., 46, 1938, 565-570.

#### SUBORDER II. Phytophagineae subordo novus.

Viruses infecting higher plants; vectors typically homopterous or hemipterous insects (leafhoppers, aphids, white flies, true bugs) or thysanopterous insects (thirps). From Greek phagein, to eat, and phyton, a plant.

#### Key to the families of suborder Phytophagineae.

- Inducing yellows-type diseases, vectors typically cicadellid or fulgorid leafhoppers.
  - Family I Chlorogenaceae, p 1145.
- Inducing mosaic diseases; vectors typically aphids. Family II. Marmoraceae, p.1163.
- 3. Inducing ringspot diseases; vectors unknown.
- Family III. Annulaceae, p. 1212.
- 4 Inducing leaf-curl diseases, vectors typically white flies. Family IV. Rugaceae, p. 1218.
- 5 Inducing leaf-savoying diseases, vectors, true bugs, Family V. Saroiaceae, p. 1221.
- 6 Inducing spotted wilt, vectors, thrips.

Family VI. Lethaceae, p. 1223

#### FAMILY I. CHLOROGENACEAE HOLMES EMEND.

(Handb. Phytopath. Viruses, 1939, 1.)

#### DELLIDAE and FULGORIDAE)

#### Key to the genera of family Chlorogenaceae.

- I True Yellows Group Viruses unducing diseases usually characterized by stimulation of normally dormant and adventitious buids to produce numerous slender shorts with long internodes and by chlorosis without spotting; invaded parts abnormally erect in habit. Vectors cleadellid leathoppers so far as known.
  - Genus I. Chlorogenus, p 1146
- Peach X-Disease Group Viruses inducing diseases characterized by rosetting of foliage and sometimes death of host

Genus II. Carpophthora, p 1151

- III Phloem-Necrovis Group. Viruses inducing diseases characterized by progressive degeneration of the host plant or by wilting and midden death; cometimes by root discoloration. Vectors cicadellid leafhoppers of far as known.
  - Genus III. Moraus, p. 1153
  - IV. Yellow-Dwarf Group Viruses inducing diseases characterized by chlorotic effects somewhat resembling true mottling but often more diffuse. Vectors cical-cliid (sgallian) leafhorpers
    - Genus IV. Aureogenus, p 1151.
  - V. Fip-Disease Group. Viruses inducing diseases characterized by marked vascular proliferation. The vector of one is known to be a leafhopper of the subfamily Delphacinae, family FULGORIDAE.

Genus V. Gallo, p. 1157.

VI. Stripe-Diseaso Group. Viruses inducing diseases characterized by chlorofic striping; hosts grasses. Vectors, cicadellid and fulgorid leafhoppers. Genus VI. Fractilinea, p. 1159.

# Genus I. Chlorogenus Holmes.

(Loc. cit., 1.)

Viruses of the Typical Yellows Group, inducing diseases usually characterized by stimulation of normally dormant and adventitious buds to produce numerous slender shoots with long internodes, by chlorosis without spotting, or by both growth of numerous slender shoots and chlorosis. Invaded parts abnormally erect in habit. Affected flowers often virescent. Hosts, dicotyledonous plants. Vectors, so far as known, exclusively cicadellid leafhoppers. Generic name from Greek chloros, light green or yellow, and suffix, gen, signifying producing, from Greek genos, descent.

The type species is Chlorogenus callistephi Holmes.

# Key to the species of genus Chlorogenus.

- I. Natural hosts many, in various families of plants.
  - Chlorogenus callistephi.
     Chlorogenus australiensis.
- II. Known natural hosts relatively few.
  - A. Natural hosts rosaceous.
  - B. Natural hosts solanaccous.
  - C. Natural host sandal.
  - D. Natural host cranberry.
  - E. Natural host locust
  - F. Natural host alfalfa
  - G. Natural host hop.
- Chlorogenus callistephi Holmes. (Handb. Phytopath Viruses, 1939, 2.)
   From New Latin Callistephus, generic name of the China aster.

Common names: Aster-yellows virus, lettuce white-heart virus, Erigeron-yellows virus.

Hosts: Callistephus chinemis Nees, the China aster, is the host that has been studied most. 170 or more species in 38 different families of dicotyledonous plants have been shown susceptible. Lettuce, endive, carrot, buckwheat, parsnip, and New Zealand spinach are among the hosts of economic importance

- 3. Chlorogenus persicae.
- Chlorogenus solani,
- 5. Chlorogenus santali.
- 6. Chlorocenus vaccinii.
- 7. Chlorogenus robiniae
- 8. Chlorogenus medicaginis.
- 9 Chlorogenus humuli.

Insusceptible species. All tested species of the family Leguminosae and some species of all other tested families have appeared naturally immune

Geographical distribution: U. S., Canada, Bermuda, Japan, and Hungary. In California the celery-yellows strain of this virus replaces the type.

Induced disease: In most host species the characteristics of disease are clearing of veins, followed by chlorosis of newly formed tissues, stimulation of normally dormant buds to growth, malformation virescence of flowers, sterility, and upvirght growth habit. Stimulation of nor

mally dormant buds to adventitious growth and abnormally erect habit are the most constant features Chlorous are absent or inconscious in some bests.

Transmission · By leafhopper, Macrosteles divisus (Uhl ) (= Cicadula sexnotata (Fall ), C. dirisa (Uhl )) (CICA-DELLIDAE). Incubation about 2 weeks. Some strains of this virus are transmitted also by the leafhoppers Thamnotettix montanus Van D and T geminatus Van D. (CICADELLIDAE) By grafting By dodder. Not through seeds of diseased plants Not by mechangeal inoculation of plants, but virus has been passed from insect to insect mechanically in Macrosteles divisus, juice from viruliferous insects contains little virus just after inoculation, but the effective concentration increases at least 100-fold between the 2nd and 12th day of a 17-day incubation period, it seems greatest before the insects begin to infect the aster plants on which they are main-

Thermal inactivation. In junce from viruliferous insects, at about 40° C in 10 minutes, at 25° C in 2 to 3 hours. In plant tissues, at 33° to 42° C, in 2 to 3 weeks, cured plants fully susceptible to reinfection. In insect vector, M. dirissus, at 31° C in 12 days.

tained

Other properties Virus in juices derived from insects is more stable at 0°C of than at 25°C or when frazen; at 0°C it withstands storage 21, not 4°s, hours in 0 85 per cent NoCl solution at pl17.0 but most of the virus is inactivated in this time; it withstands dilution 1:1000 in neutral 0.85 per cent NoCl solution, for bird (less than 5-minute) expoures, it remains viable over the range from pl1.5 to 9.

Literature. Black, Phytopath, \$t\_1, 1911, 120-135; 53, 1913, 2 (Abat.); Johnson, 15td, \$d\_1, 1911, 619-656; Kunkel, Am. Jour Bot, \$t\_3, 1920, 646-765; Contrib Bayer Thompson Irst, \$t\_1, 1913, Ks-123, \$t\_1932, 405-414; Am. Jour Bot, \$t\_4, 1932, 405-414; Am. Jour Bot, \$t\_4, 1937, 405-427; \$t\_2, 1911, 761-769; Linn, Cornell Agr. Lips, Sta (Libraes), Bull.

742, 1940; Ogilvie, Bermuda Dept. Agr., Agr Bull 6, 1927, 7-8; Severn, Hilgardia, 5, 1929, 543-583; Phytopath., 20, 1930, 920-921; Hilgardia, 7, 1932, 163-179; 8, 1934, 393-325, 323-361; Phytopath., 20, 1940, 1019-1031; Hilgardia, 14, 1942, 411-440; Severin and Haasis, Hilgardia, 8, 1931, 323-335.

Strains. Two variant strains, one found in nature, the other derived experimentally, have been given varietal names to distinguish them from the type variety, rulgaris II (loc. cit, 2):

la. Chlorogenus collistephs var. californeus II. (toc. ctt., 3) From California,
name of state in which this strain was first
recognized Common name Celery-yelloss strain of aster-yellows virus. Differing from the type variety by ability to
infect celery (Apium gracelons L—
UMBELLIFERAE) and zinnia (Zinnia
degan) Jacq—COMPOSITAE) (Kunkel, Contrib Boyee Thompson Inst., 4,
1902, 405–414, Severin, Illigardia, 5, 1929,
543–5535, 8, 1934, 305–325).

lb Chlorogenus callistephi var. attenuatus II. (Ioc. cit. 4). From Latin attenuatus, weakened Common name: Heat-attenuated stram of aster-sellows virus Differing from the type variety by inducing less severe chlorosis and less uprightness of new growth in affected aster plants (Kunkel, Am. Jour. Bot., 24, 1937, 316-327).

2. Chlorogenus australiensis comb. nor. I'rom Australia, name of continent. Synonym. Galla australiensis II (loc. cit. 107)

Common names: Tomato big-bud virus; virerence virus; perhaps also stowhoor virus, tobacco stolbur or montar virus, eggplant little-lest virus.

Hosts: SOLANACSAE-Datura stranonium L. Jimson weed; Lycopersicon seculentum Mill., tomato; Nucetiana talacum L., toharco; Solanura reclomena L., ersplant; S. nigum L. black nightshadelecentity a long list of species in this and other families have been reported as susceptible to virescence virus, presumed to be an isolate of tomato big-bud virus. (Hill, Jour. Counc. Sci. Ind. Res., 16, 1943, 85-92).

Geographical distribution: Australia, especially New South Wales; viruses causing somewhat similar diseases have been reported also from the Crimea and the northwestern United States.

Induced disease: In tomato, flowers erect, virescent, calyx bladder-like, pollen sterile; floral proliferation. Growth of avillary shoots stimulated. leaves progressively smaller. Youngest leaves yellowish-green in color, especially at their margins; usually purplish underneath. Hypertrophy of inner phloem. No intracellular inclusions. Fruit reddens imperfectly and becomes tough and woody. Roots appear normal. In Solanum nigrum, axillary shoots numerous. leaves small, internal phloem adventitious. In tobacco, plants dwarfed; leaves recurved, distorted, twisted, thickened, brittle, yellowish green, hanging down close to stem; small leaves on shoots from axillary buds; proliferation and virescence of flowering parts; chlorotic clearing of veins as early effect of disease; upper surface of foliage appears glazed; some necrosis of veins, in old leaves, near tips and margins or on midrib; viable seed rarely produced; calyx bladder-like, floral axis may form short branches bearing small leaves; disease sometimes called bunchy top.

Transmission: By leafhopper, Thamnotettic argentata Evans (CICADELLI-DAE). Experimentally by budding and other methods of grafting. Not by moculation of expressed june.

Literature: Cobb, Agr. Gaz. New South Wales, 13, 1902, 410-414; Dana, Phytopath, 30, 1910, 863-860; Hill, Jour. Austral. Inst. Agr. Sci. 6, 1940, 190-260; Jour. Council Sci. Ind. Res., 10, 1937, 309-312; 16, 1943, 85-92; Michailowa, Phytopath, 25, 1935, 530-558; Rischkov t al., Zischt. Pflanzenkr, 43, 1933, 196498; Samuel et al., Phytopath., 23, 1933, 641-653.

3. Chlorogenus persicae II. (loc. cit., 5). From New Latin Persica, former generic name of peach.

Common names: Peach-yellows virus, little-peach virus.

Hosts: ROSACEAE—Prunus persica (L.) Batsch, peach; P. salicina Lindl., Japanese plum; and all other tested species of the genus Prunus.

Geographical distribution: Eastern United States and Canada, south to North Carolina. First occurred near Philadelphia in this country. Origin perhaps oriental; introduction in oriental plums suspected. Not in Europe.

Induced disense: In peach, clearing of veins, production of thin erect shoots bearing small chlorotic leaves, followed by death in a year or two. In early stags of the disease there is premature ripening of fruit. In Japanese plum, systemic infection but no obvious symptoms

Transmission: By the leafhopper, Macropsus trimaculata (Fitch) (CICADEL-LIDAE). By budding; virus spreads down stem from point of bud insertion faster than up. Not by inoculation of expressed juice, despite numerous attempts. Not by pollen of diseased trees.

Immunological relationships: Presence of peach-yellows virus immunizes tree against little-peach virus, formerly considered an independent c tity.

Thermal inactivation · in peach tissues, at 34° to 35° C in 4 to 5 days; at 44° C in 30 minutes, at 47° C in 10 minutes; at 50° C in 3 to 4 minutes; at 50° C in 15 seconds.

Other properties: Trees and bud sticks may be treated safely with heat sufficient to kill the virus. Cured trees are susceptible to reinfection.

Literature: Blake, N. J. Agr. Exp. Sta., Bull. 226, 1910; Kunkel, Contrib. Boyce Thompson Inst., 5, 1933, 19-28; Phytopath., 26, 1936, 201–219, S09–830, 28, 1938, 491–497; Manns, Trans. Peninsula Hox-Soc, 28, 1933, 17-19; Manns and Manns, ibid., 24, 1934, 72-76, McCubbin, Pennsylvania Dept. Agr., Gen. Bull. 382, 1924

Strains: Numerous strains of peachyellows virus probably exist in nature One of these has been given a varietal name, distinguishing it from the type variety, sulgaris II. (loc. cst, 5):

3a. Chlorogenus persicae var. micropersica II. (loc. cit . 6). From Greek micros. small, and New Latin Persica, former generic name of peach Common name Little-peach strain of peach-vellows virus. Differing from the type variety by tendency to cause a mild type of disease. characterized by distortion of young leaves, production of many short branches on main trunk, later yellowing of mature leaves, twiggy growth, shoots slightly less creet than in typical peach yellows (Kunkel, Phytopath., 26, 1936, 201-219. 26, 1936, 809-830; 28, 1938, 491-497, Manns, Trans. Peninsula Hort Soc , 23, 1933, 17-19; 24, 1931, 72-76)

Chlorogenus solani H (loc cit, 7)
 Prom New Latin Solanum, generic designation of potato. Synonym: Chlorophthora solani McKinney, Jour Washington Acad. Sci., 34, 1914, 151.

Common names: Potato witches'-broom virus, potato wilding or semi-wilding virus,

Hosts: SOLAN.ACEAE—Solanum tuberosum L., potato. Experimentally, also SOLAN.ACEAE—Lycopersicon essulentum Mill., tomato; Nicoliana tobacum L. tobacco; N. glutinosa L.; N. rustica L. POCYNACEAE—Vinca rosea L., periwinhle, CHENOPODIACEAE— Beta rulgars I., sugar beet.

Geographical distribution United States (Montana, Washington), Russia

Induced disease: In potato, increasingly pronounced flave-scence in new leaflets on one or more stems, production of new dwarfed leaflets with marginal flave-cence on stems with unusually long interpodes and enlarged nodes, growth of spunding availary, and lavel branches profuse bleoming and fruiting, lack of dormancy in tuber buds, formation of many small underground tubers as well as some aerial tubers; plants grown from diseased tubers form thread-like stems and small simple leaves; infected plants survive several seasons, with progressive degeneration In tomato, experimentally, extreme leaf dwarfing, marginal flavescence of leaves and abnormally numerous axillary branches, stems become hollow and die; plants do not survive long after infection. In tobacco, experimentally, slender axillary branches with dwarfed leaves, flowers on spindling pedicels, numerous, small, later leaves flaves-

Transmission By tuber-core grafts with prepatent period of 2 to 114 days. By stem grafts. By dodder, Cueuta campestris Yuncker (CONVOLVULA-CEAE) Not by inoculation of expressed junce Not by Macrositels divisus (UII) (CICADELLIDAE). No insect vector is known Not through seeds of directed tomates.

cent or marginally flavescent

Thermal inactivation at 42° C in 13 days, in tissues of Vinca rosea; at 36° C in 6 days in small potato tubers.

Laterature Hungerford and Dana, Phytopath 14, 1921, 372-383, Kunkel, in Virus Diseases, Cornell Univ Press, Ithaca, N. Y. 1913, 63-82; Proc. Am. Philosoph Soc. 66, 1913, 470-475, Me-Larty, Scient Agr. 6, 1926, 395, Whipple, Montana Agr Exp Sta, Bull 130, 1919; Young, Science, 66, 1927, 301-306; Am Jour Bot. 16, 1929, 277-273, Young and Morris, Jour Agr Res. 36, 1928, 835-851.

5 Chlorogenus santali II. (loc. cit., 8). From New Latin Santalum, generic designation of sandal

Common names. Sandal spike-disease virus, sandal spike-rosette virus.

Hosts SANTALACEAE—Santalum album L., sandal Spike-like discusses lave been found also in RHAMNEAE—Zrzyphus conceptia Mill, SAPINDA-CEAE—Dolanaca currora Jucq. VIR.

 Inducing rosette formation characteristically, but not tattering of affected foliage.

 Carpophthora lacerans (Holmes) McKinney. (Marmor lacerans Holmes, Handb. Phytopath. Viruses, 1939, 82;
 McKinney, Jour. Washington Acad. Sci., 34, 1944, 152.) From Latin lacerare, to lacerate, in reference to characteristic foliage injury.

Common name: Peach X-disease virus; virus of peach yellow-red virosis.

Hosts: ROSACEAE—Prunus persica (L.) Batsch, peach; P. virgminna L., chokecherry.

Geographical distribution: United States, Canada.

Induced disease: In peach, foliage normal each spring but yellowish areas appear in June at base of leaves; affected trees appear lighter green than neighboring healthy trees; discolored spots occur at random on the leaf blade, becoming red and yellow with remainder of leaf becoming chlorotic; the discolored areas usually fall out, leaving the foliage tattered; subsequently, affected leaves drop except at tips of branches; young trees may die, older ones survive indefinitely. Fruit either shrivels and falls or ripens prematurely, with bitter flavor and no viable seed. In chokecherry, conspicuous premature reddening of foliage, development of fruits with dead embryos in the pits, in the second and third seasons after infection, duller colors of foliage, rosettes of small leaves on terminals, death follows the advanced stage of disease.

Transmission: By budding. Not by inoculation of expressed juice. No insect vector has been reported.

Literature: Berkeley, Drv. of Botany and Plant Path , Science Service, Dominion Dept. Agr., Ottawa, Canada, Publication 678, 1941; Royd, U. S. Dept. Agr., Plant Dis. Rep. 22, 1938, 334, Hildebrand, Contrib. Beyce Thompson Inst., 11, 1941, 485-496; Hildebrand and Palmiter, U. S. Dept. Agr., Plant Dis. Rep.

2. Carpophthora resettae.

22, 1938, 394-396; Hildebrand et al. Handbook of virus diseases of stone fruits in North America, Michigan Agr. Exp. Sta., Misc. Publ., 1942, 21-24; Stoddard, Connecticut Agr. Exp. Sta., Crnt. 1tt, 1938, 54-60; Proc. Connecticut Pamel. Soc. 48, 1938, 29-32.

2. Carpophthora rosettae (Holmes) comb. nos. (Chlorogenus rosettae II, nomen nudum, Phytopath. 19, 1029, 434; Nanus rosettae II., Handb. Phytopath. Viruses, 1039, 125.) From rosette, common name of induced disease, from French, diminutive of rose, a rose.

Common name: Peach-rosette virus.

Hosts: ROSACEAE—Prunus persia
(L.) Batsch, peach; P. communis Fitisch,
almond; P. demestica L., plum. Experimentally, also-APOCYNACEAE—
Vinca rosea L., periwinkle. ROSACEAE—P. americana Marsh, wild plum,
P. americana C., apriect; P. ceraus Locherry; P. pumila L, sand cherry.
SOLANACEAE—Lycoperation excultatum Mill., tomato, Nicotiana gulturosa I.

Geographical distribution: United States (Georgia, Alabama, South Carolina, Tennessee, West Virginia, Missouri, Oklahoma).

Induced disease: In peach, sudden witting and death, or growth of abnormally short stems bearing dwarfed leaves with clearing and thickening of veins, followed by death in a few months.

Transmission: By budding. By dodder, Cuscula campestris Yuneker. Not by inoculation of expressed juice. Not through soil. No insect vector is known.

Immunological relationships: No protection is afforded by previous infection of peach trees with Chlorogenus persical, peach-yellows virus.

Thermal inactivation: At 50° C in 10 minutes (in tissues of peach). Rosetted trees are abnormally susceptible to heat

injury and heat treatments cure peachrosette disease only in recently infected trees.

Literature: Kunkel, Phytopath, 26, 1936, 201-219, 809-830; in Virus Diseases,

Cornell Univ. Press, Ithaca, N. Y, 1943, 63–82; McClintock, Jour. Agr. Res., 24, 1923, 307–316, Phytopath., 21, 1931, 373–386, Smith, U. S. Dept. Agr., Div. Veg. Path., Bull. 1, 1891.

#### Genus III. Marsus gen nov

Alfalfa-Dwarf Group, viruses inducing diseases characterized in general by sudden writing and death or by gradual decline of vigor with foliage of darker green color than normal. Vectors, like those of the typical yellows subgroup, ciacallitic leafiloppers so far as known. Generic name from Latin morsus, sting or vexation. The type species is Morsus sufforcine spec. nov.

#### Key to the species of genus Morsus.

- I. Affecting alfalfa and grape
- II. Affecting tobacco.
- III. Affecting clm.
- Morsus suffodiens spec. nov. From Latin suffodere, to sap or undermine, in reference to process leading to sudden collapse of long infected, but sometimes not obviously injured, grape vines as well as to progressive decline in size of infected alfalla plants, the foliage of which

may remain green to the last Common names: Alfalfa-dwarf virus, lucerne dwarf-disease virus, virus of

Pierce's disease of the grape, virus of Anaheim disease

Hosts: LEGUMINOSAE—Medicago satira I., alfalfa (lucerne). VITA-CEAE—Vitis rinifera L, grape.

Geographical distribution United

Induced disease: In alfalfa, leaves small but green, plant progressively smaller, wood of roots diseolored yellow, transpiration decreused; wilting may occur; starch of root diminished, plant exentually auccumbs, thinning stand prematurely. In grape, dark green color of leaves retained along veins, not between them, or no abnormality in appearance of folicyse; wilting and audden death of plant in summer of second year. In late summer of first year, later may be

1 Morsus suffodiens.

- 2. Morsus reprimens.
  - ...
- 3. Morsus ulm:.

dying leaf margins and dying back of cane tips

Transmission By budding and root grafting. By leadinppers, Draceulaezphala minerta Ball, Carnecephala fulgida Nott, C truputata Nott, Heleokara detta Oman, Neokolia etreellata (Baker), N. gothica (Sigin), N. confuens (Uhler), N. hetroglyphea (Say), and Cuerna occidentalis Oman and Beamer (CTCA-DULLIDAE), these vectors all being to the subfamily Amblycephalinee, all tested species of this, but none of any other, subfamily have proved capable of transmitting this virus. Not by insculation of expressed junce. Not through soil

Laterature Trazier, Phytopath, 31, 1914, 1000-1001, Henuit, Phytopath, 22, 1933, 10, 31, 1911, 852, Mue Anchor, 18, 1911, 16-21, 36, Henuit et al., Phytopath, 52, 1912, 8, Houston et al., Phytopath, 52, 1912, 10; Milbrath, Calif Dept. Agr., 20th Ann. Rept., 18th. 28, 1910, 671, Pherce, U. S. Dept., of Agr., Div., of Ver. Phytopath, 21, 1931, 71-75, 27, 1937, 077-702, Jour. Agr. Res., 47, 1933, 331-265, 84, 1905, 333-371; 85, 1937, 87-10

2. Morsus reprimens spec. nov. From Latin reprimere, to restrain, check, or curb, in reference to the inhibiting effect on growth of the host plant, tobacco.

Common name: Tobacco yellow-dwarf virus.

Hosts: SOLANACEAE—Nicotiana tabacum L., tobacco, N. rustica L., Indian tobacco; N. trigonophylla Dun. Experimentally, also N. glavaca Grah. (symptomicss) and N. glutinosa L.

Geographical distribution: Australia (Victoria, New South Wales, South Australia, and southern Queensland).

Induced disease: In tobacco, internodes of stem shortened, leaves small; downward bending of tips and rolling under of margins of young apical leaves; young leaves darker than normal at first, bunched, later appear ribbed; leaves become yellow-green, pale first between veins; old leaves rugose, thickened, later savoyed. Root system small, roots slightly brown externally and in the region of the phloem. Affected plants may survive the winter and show diseased new growth in the apring

Transmission. By grafting and budding By nymphs and adults of the leafhopper, Thamnotettix argentata (Evans) (CICADELLIDAE).

Literature: Dickson, Australia, Council Sci. Indust. Res., Pamphlet 14, 1929, 22; Hill, Australia, Journal of the Council Sci. Indust. Res., 10, 1937, 228-230; 14, 1941, 181-186; 16, 1942, 13-25.

3. Morsus ulmi spec. nov. From Latin ulmus, elm.

Common name: Elm phloem-necrosis virus.

Host: URTICACEAE-Ulmus americana L., American elm.

Geographical distribution United States (Ohio, Indiana, Illinois, Missouri, Tennessee, Kentucky, and West Virginia).

Induced disease: In elm, gradual decline over a period of 12 to 18 months before death or sudden witt, drying of leaves, and death within 3 to 4 weeks. All ages susceptible, from seedling to large tree.

Transmission: By patch grafting. Not by inoculation of expressed juice.

Literature: Leach and Valleau, U. S. Dept. Agr., Plant Dis Rept., £5, 1939, 300-301; Swingle, Phytopath., 50, 1940, 23.

# Genus IV. Aureogenus Black.

(Proc. Am. Philos. Soc., 88, 1944, 141.)

Viruses of the Yellow-Dwarf Group, inducing diseases characterized by yellowing without typical messic-type motiting. Vectors agallian leathoppers (CICADELLI-DAE). Generic name from Latin aureus, yellow or golden, and genus, group.

The type species is Aureogenus vastans (Holmes) Black.

## Key to the epecies of genus Aureogenus.

- Mechanically transmissible in some hosts by rubbing methods of incculation. Not producing enlarged veins or club-leaf in clover.
  - 1. Aureogenus vastans.
- Not known to be transmissible by rubbing methods of inoculation.
   A. Producing calarged veins in clover
  - Aureogenus magnivena.
  - B. Producing club-leaf in clover-
- 3. Aureogenus clavifolium.

Broth: Turbid with marked fluorescence.

Litmus milk: Unchanged. In association with lactic acid bacteria the milk takes on a deep blue color

Potato: Yellowish-gray, shiny layer, becoming bluish-gray The medium becomes bluish-gray

Indole not formed.

Nitrites not produced from nstrates Aerobie, facultative

Optimum temperature 25°C

Habitat: The cause of blue milk

11. Pseudomonas schuylkilliensis Chester. (Bacillus fluorescens schuyl-Ailliensis Wright, Memoirs, Natl Acad Sci., 7, 1895, 448, Chester, Determinative Bact., 1901, 320 ) From M L of the Schuylkill (River)

Synonyms: Pseudomonas capsulata Chester, Man. Determ Bact , 1901, 322 (Bacillus fluorescens capsulatus Pottien, Ztschr. f. Hyg , 11, 1896, 140), Pseudo monas dermatogenes Puhrmann, Cent f. Bakt., H Abt , 17, 1906, 356

Short rods, with rounded ends, occurring singly, in mairs and in chains tile, possessing a polar flagellum Grumnegative.

Gelatin colonies Grayish-white, trans lucent, with brownish center, radiate margin, becoming bluish green

Gelatin stab; Slow erateriform fique faction, with blue green fluorescence Ague elant: Gravish. translucent

growth. Medium shows greenish fluorescent.

Broth: Turbid, with slight pellicle and blue-green fluorescence Stringy sediment.

Litrary milk: Congulated, with slow reduction of himus; peptonized

Potsto; Brownish, spreading, vierid, thick. Indule is formed (trace)

Nitrites not produced from aitrates Acrobic, facultative

Does not grow at 35° to 36°C

Source: Isolated from Schuvlkill Rive water.

Habitat: Water.

12 Pseudomonas chlororaphis (Guignard and Sauvageau) Bergey et al. (Bucillus chlorgraphis Guignard and Sauvageau, Compt. rend. Soc. Biol. Paris, 1, 10 sér., 1894, S41; Bergey et al., Manual. 3d ed , 1930, 166; also see Lasseur and Dupaix-Lasseur, Trav. Lab. Microbiol Fac Pharm. Nancy, Fasc. 9, 1936, 25.) From Greek, chloros, greenish yellow; raphis, needle

Rods: 0.S by 1.5 microns, with rounded ends, occurring singly and in pairs. Motile with polar flagella. Gram-negative,

Gelatin colonies. Circular, viscid. transparent, glistening, lobate margin, with fluorescent corona Dissociates readily (Lasscur and Dupair-Lasseur. cil ). loc

Gelatin stab · Stratiform liquefaction. Broth . Turbid, fluorescent, with crystals of green, water-soluble chlororaphine.

Litmus milk: Congulation. Pentonization Crystals of chlororaphine form in the central part of the culture.

Potato Citron-vellow layer. Crystals of chlororaphine are formed

Natrates reduced to nitrates.

Indole not formed Pigment formation · Asparagine, potas-

sium phosphate, glycerol, sulfate of magnesium and sulfate of fron are indispensatile to the formation of crystals of chlororaphine. Aerobse, facultative Ontinum tem-

perature 25° to 30°C

Pathogenic for laboratory animals. Exotorin formed

Habitat: Water.

flarella. Gram necative.

13 Pseudomonas myzogenes Fuhrmann. (Cent f Pakt, II Abt., 17. 1907, 356) From Greek, myra, mucus, gentad, to leget, M. I. slime producing

Rods 04 to 03 by 10 to 15 microns. occurring singly and in purs Motile, possessing a landle of five to seven polar

Filterability: Passes Berkefeld W

Other properties: Virus viable at 23 to 27° C less than 13 hours after extraction of juice from diseased plant; not infective after drying in leaf tissues.

Literature: Barrus and Chupp, Phytopath., 12, 1922, 123-132; Black, Am. Potato Jour., 11, 1931, 148-152; Cornell Univ. Agr. Exp. Sta., Mem. 209, 1937. 1-23; Phytopath., 28, 1938, 863-874; Am. Jour Bot., 27, 1940, 386-392; Am. Potato Jour., 18, 1911, 231-233; Phytopath., 53, 1913, 363-371; Genetics, 28, 1913, 200-209; Proc. Am. Philos. Soc., 88, 1941, 132-144; Hansing, Cornell Univ. Agr. Evp. Sta., Bull. 792, 1943; Price and Black, Am. Jour. Bot , 28, 1911, 591-595; Taylor, Am. Potato Jour., 15, 1938, 37-40; Walker and Larson, Jour. Agr Res., 59, 1939, 259-280; Watkins, Jour. Econ Ent., \$2, 1939, 561-564; Cornell Univ. Agr. Exp. Sta , Bull. 758, 1911, 1-21; Younkin, Am. Potato Jour . 19, 1942, 6-11.

Strains: Boside the type variety, Aureogenus rastans var. vulgare Black (Am. Jour. Bot. 27, 1940, 391), on which the species is based, two distinctive strains have been given varietal names:

la. Aureogenus vastans var. agalliae Black. (Am Potato Jour, 18, 1941, 233.) From New Latin Agallia, generic name of vector of this strain Common name: New Jersey strain of potato yellow-dwarf virus Differing from the type especially in its distinctive vector, the leafhopper, Agallia constricts Van Duzce, which is incapable of transmitting the type strain, and in not being transmitted by Accratagallia sanguinolenta (Provancher), common vector of the type variety mentally, transmitted also by Agallia quadripunctata (Provancher), perhaps rarely by Agalliopsis novella (Say). Differing but little from the type in effects on potato (var Green Mountain) and Necotiana rustica but more definitely in effects on crimson clover, in affected plants of which a rusty-brown necrosis

along the veins, not induced by the type strain, is always present in some degree,

1h. Aurcogenus vastans var. lethate Black. (Am. Jour. Bot., 27, 1940, 291.) From Latin lethalis, causing death. Common name. Strain B5 of potato yellow-dwarf virus. Differing from the type variety especially in a tendency to induce in Nicotiana rustica, experimentally, brown primary lesions with necroite gray centers, systemic yellowing, extensive necrosis of veins, collapse of large areas of leaf, and sometimes death of the host; not known to occur in nature as a separate strain, but readily isolated as a variant from strains collected in nature.

2. Aureogenus magnivena Black. (Proc. Am. Philos. Soc., 88, 1914, 144.) From Latin magnus, large, and tena, vein.

Common name: Clover big-vein virus.

Host: Experimentally, LEGUMINOSAE-Trifolium incarnatum L., crimson
clover.

Insusceptible species: SOLANA-CEAE-Nicotiana rustica L, Indian tobacco; Solanum tuberosum L., potato.

Geographical distribution: United States (presumably, Washington, D. C).

Induced disease: In crimson clover, experimentally, unevenly thickened veins which are depressed below the upper surface of the leaf; these enlarged veins, best observed from below, sometimes bear enations that arise from their lower surfaces, leaves often curl upward and inward marginally, in summer, yellowing of leaves progresses from margins inward, the yellow color being later replaced in part by red or purple red; petioles undulating; plants dwarfed; internodes shortened; no clearing of veins, no rusty-brown necrosis.

Transmission: Not by inoculation of expressed juice. By leafnoppers, Agalinopass novella (Say), Agalina constructs Van Duree, A quadripunctata (Provsacher); not by Acerdagalina sanguino-tenta (Provancher) (CICADELLIDAE).

1. Aureogenus vastans (Holmes)
Black (Marmor castans Holmes,
Handlb Phytopath, Viruses, 1939, 94;
Black, Proc. Am. Philos. Soc., 83, 1944,
141.) From Latin rastare, to devastate

Common name: Potato yellow-dwarf virus

Hosts: SOLANACEAL—Solamm tuberosum L., potato COMPOSITAL— Chrysanthenum leuconthemum L., var. punnatifidum Lecoq and Lamotte, daisy; Rudbecka hurta L., black-eyed Susan. CRUCIFIRIAE—Barborca eulgaris R. Br., common winter cress. LEGU-MINOSAE—Trifolium pratense L., red clover Experimentally to numerous species in thece and other families.

Geographical distribution: Northeastern United States and southeastern Canada.

Induced disease: In potato, yellowing of leaves, necrosis of stem, dwarfing of plant, the stem, if split, shows rusty specks especially at nodes and spex; the aper dies early, tubers are few, small, close to the stem, often cracked, with flesh discolored by scattered brown specks, seed tubers tend to remain unrotted in the ground, becoming hard and glassy, some of them do not germinate in warm soil, others produce shoots that die before reaching the surface, giving poor stands In Chrysunthemum leucanthemum tar pinnatisidum, at first, clearing of veins, later, young leaves distorted, thick, stiff, small; petioles short, leaves erect, forming a rosette at the erown of the plant, with passing of the early phases of the disease, foliage tends to مواعدك وكالمسمدة بالماسيدم ماري

and after the period of obvious disease and infected plants may constitute an important reservor. In Trifolium incoractum 1, crimon obvere, experimentally, clearing of veins and yellowing of yourger leaves (in number the yellowing is usually replaced in part by an interveinal reddish-brown color on both leaf surfaces extending from the margins inwards); dwarfing of entire plant; death or a chronic disease characterized by milder manifestations without, however, vein enlargement or cupping of leaves. In Nicotiana rustica L., experimentally, yellowish primary lesions followed by clearing of veins and systemic chlorosis; the primary lesions facilitate quantitative estimation of concentrations of this vivins.

Transmission: By inoculation of expressed juice, in the presence of finely powdered carborundum, to Nicotiana rustica: mechanical transmission very difficult in other hosts tested. By graft. ing. By clover leafhopper, Aceratagallia sanguinolenta (Provancher): experimentally, by other closely related leafhoppers, Aceratagallia lurata (Baker), A. obscura Oman, and A currate Oman; not (for the type variety of the virus) by Apallia constricta Van Duzee, very rarely by Agallia quadripunctata (Provancher) and Agailiopsis novella (Say) (CICADELLI-DAC). The vector Accratagallia sanquinolenta remains infective as an overwintering adult; incubation period not less than 6 days, commonly much longer: virus does not pass to progeny of viruliferous leafhoppers through eggs or sperm; this leafhopper varies genetically in ability to transmit.

Immunofecial relationships: No protection is afforded against necrotic effects of a testing strain of this virus (var.
tethale Black) by prior inoculation of
Nicoltana ruttea with isolates of Marror
medicaginis, M. cucuneris, M. upulon,
Annulus tolaci, A. orae, or A. dubius,
but the varieties rulgare Black and agaltione Black protect; these specifically protecting strains give no similar protection
against formation of recrotic lesions by
subsequently applied isolates of Marror
tolaci, M. Idi ale, Annulus tolaci, or A.
orae.

Thermal inactivation: At 50 to 52° C in 10 minutes.

Ser., 5, 1924, 99-107; Lyon, *ibid.*, 5, 1921, 1-43; Hawaiian Planters' Rec., 12, 1915, 200; Mungomery and Bell, Queensland, Bur. Sugar Exp. Sta., Div. Path, Bull. 4, 1933; Octemia, Am. Jour. Bot., 21, 112, 112, 113.

 Galla queensiandiensis H. (loc. cit., 109). From Queensland, where the induced disease was first studied

Common name: Sugar-cane dwarf-discase virus.

Host: GRAMINEAE-Saccharum officinarum L., sugar cane.

Geographical distribution: Queensland. Induced disease: In sugar cane, young leaves marked with scattered chlorotic streaks, leaves stiff and erect, spindle twisted, abnormally short and pale. As leaves mature, streaks disappear, leaves become darker than normal green. In recently infected plants, vascular bundles are enlarged, irregular in shape, fused and characterized by abnormal proliferation of thin-walled lignified cells.

Literature: Bell, Queensland, Bur. Sugar Exp. Sta, Div Path, Bull. 3, 1932.

Galla anemones H. (loc cit., 108).
 From Latin anemone, anemone or wind-flower.

Common name: Anemone-alloiophylly virus.

Hosts: RANUNCULACEAE—Anemone nemorosa L., vernal windflower; A ranunculoides L., A trifolia L.

Geographical distribution Germany.

Induced disease: Leaves thickened and distorted, petioles thickened. Flowers distorted or not formed. Vascular bundles larger and more numerous than in healthy plants. Palisade cells short, chloroplasts smaller and fewer than normal.

Transmission. By needle puncture into rhizomes immersed in filtered juice of diseased plant. By contamination of soil with fragments of diseased leaves or rhizomes.

Literature: Klebahn, Bericht. d Deutsch. Bot. Gesellsch., 16, 1837, 527-536; Zitschr. wissensch. Biol., Abt. E., Planta, 1, 1926, 419-440; 6, 1923, 40-95; Phytopath. Zitschr., 4, 1932, 1-36; 8, 1936, 357-370.

4. Galla verrucae Blodgett. (Phytopath, 33, 1943, 30) From Latin erruca, wart. Originally spelled erruca, apparently by a typographical erro, which was corrected twice on the following page, once in a statement that the genitive errucae had been given as specific epithet.

Common name: Peach-wart virus

Host: ROSACEAE-Prunus persica (L.) Batsch, peach.

Geographical distribution: United States (Idaho, Washington, Oregon).

Induced disease: In peach, no characteristic effect on foliage. Fruits blistered, welted, later with warty outgrowths conspicuously raised. Affected tissues light tan to red, rough, cracked and russeted, or smooth. Gumming usual, often severe. Warty tissue superficial; underlying tissues coare, filled with gum pockets, but not ahnormal in flavor. Warty tissue may be hard and bony, but more often it is merely tougher than normal.

Transmission: By budding and inarching.

Literature: Blodgett, Phytopath., 51, 1941, 859-860 (Abst.); 53, 1943, 21-32.

5. Galla zeae McKinney. (Jour. Washington Acad. ' i , 54, 1944, 328 ) From Latin zea, a hand of grain

Common name; Wallaby-ear disease

Virus
Host: GRAMINEAE-Zea mays I.,
corn (maize).

Geographical distribution: Southeastern Queensland, Australia.

Induced disease. In cotu (naire), small swellings on secondary veind on undersides of young leaves, spreading thase and tip of leaf along veins; plant dwarfed, becoming abnormally deep form and deficient in development of police, silk, cobs, and grain retarded in growth.

3. Aureogenus clavifolium Black (Proz. Am Philos. Soc., 83, 1911, 141.) From Latin clava, club, and folium, leaf.

Common name: Clover club-leaf virus.

Host. Experimentally, LEGUMINOSAE-Trifolium incarnatum L., crimson

clover.
Insusceptible species SOLANA-CEAE-Nicotiona rustica L , Indian tobacco, Solanum tuberojum L , potato.

Geographical distribution: United States (Princeton, N. J.).

Induced disease: In crimson clover, experimentally, youngest leaves lighter green than normal, slow to unfold; leaf margins yellowed or colored red or purple red; affected leaves narrow, smooth or savoyed; plant dwarfed, new shoots from leaf axis slightly stimulated; new growth of spindly stoms and small leaves; no rusty-brown necrosis of veins, no obvious enlargement of veins, and no obvious clearing of veins at the onset of disease.

Transmission: Not by inoculation of expressed juice. By leafhopper, Agallopsis novella (Say) (GIGADELLI-DAE); not by leafhoppers, Acertalgallia constructa (Provancher), Agallia constructa Van Duxce, nor A. quadrippincidata (Provancher) (GIGADELLIDAE).

Genus V. Galla Holmes

(Loc. cat., 106)

Viruses of the l'iji-Disease Group, inducing diseases characterized by vascular proliferation. Generic name from Latin galla, a gall nut

The type species is Galla figures: Holmes

Key to the species of genus Galla.

I Infecting sugar cane.

\ Inducing formation of conspicuous galls.

1 Galla finensis.

B Not inducing formation of conspicuous galls.

2. Galla queenslandiensis

II Infecting anemone

3 Galla anemones

III Infecting peach.

4. Galla verrucae,

IV Infecting corn.

5. Galla zene

1 Galla fijiensis Holmes (Handb Phytopath Viruses, 1939, 195) From

name of Fig. Islands
Common name Fig.-disease virus
Host. GRAMINEAE—Saccharum offi-

cingrum L., sugar cane
Geographical distribution: Fiji Islands,

Geographical distribution: Fiji Islands New South Wales, Java, Philippine Is lands, New Guines and New Caledonia

Induced disease. In sight case, galls on vascular bundles, formed by prolifera tion of phloem and nearby cells. At feeted cells show characteristic spherical or oval inclusion lesdies. Developing leaves shortheed, crumpled, absormally dark green. Infected stools of case be-

Transmission, By leffloppers, Felinsiella neckaricals Kirk, in Queenlandl, and P., rantatirs Breddin, fin Philippine, Islands) (FULGORIDAE, autifamily Diphacaner). Not by grafting. Not by moculation of expressed juice. Not through ergs of Praidatirs. Cuttings taken from affected came produce some healthy and some diseased plants, because urras does not become uniformly distributed throughest the bost transmis-

Laterature Kunkel, Bull I ap Sta . Hawanan Sugar Planters' Assoc , Bot .

maize-streak virus. Differing from the type strain in being specialized for attacking sugar cane, in which the type (from maize) tends to be localized or finally lost with resultant spontaneous recovery of the temporary host. The cane-streak strain usually spreads readily in the cane plant; leaves become much marked with broken, narrow, pale, longitudinal stripes and spots; stems remain unaffected. One variety of sugar cane, POJ 213, is resistant and, if infected, tends to recover, (McClean, Intern. Soc Sugar Cane Techn., Bull. 27, 1932; Proc. So. Afr. Sugar Techn. Assoc., 1936, 1-11; Storey, Rept. Imp Bot. Conf., London, 1924, 132-144; Union So. Afr. Dept. Agr , Sci. Bull. 39, 1935 , Ann Appl. Biol., 17, 1930, 691-719.

1b Fractilinea maids var. milis H. (loc. cit, 58). From Latin mitis, mild. Common name: Mottle strain of maize-streak virus. Differing from the typical strain by the mildness of the disease induced in corn (maize), transitory chlorotic mottling of newly developed leaves, followed by fading of mottling and production of apparently normal leaves Young leaves, while mottled, are less rigid than normal and may not remain as nearly erect as healthy leaves (Storey, Ann. Appl. Biol., 24, 1937, 57-94)

Fractilinea oryzae (Holmes) comb.
 Marmor oryzae Holmes, loc cit,
 From Latin oryza, rice.

Common name: Rice dwarf-disease virus.

Hosts. GRAMINEAE—Oryza satira L, rice. Experimentally, also Alopecurus fulus L, Avena satira L, oat; Echinochloa crusgalli Beauv var. edulis Honda, Panicum milioceum L; Poa pratensis L; Secale cerale L. rye; Triticum vulgare Vill, wheat

Insusceptible species: GRAMINEAE
—Zea mays L, corn (maize); Hordeum
vulgare L., barley; Setaria stalica Beauv.,

fortail millet; Andropogon sorghum Brot.
(= Holcus sorghum L.), sorghum.
Generanhical distribution.

Geographical distribution: Japan, Philippine Islands.

Induced disease: In rice, yellowish green spots along veins of young leaf, followed by chlorotic spotting and streaking of subsequently formed leaves. Growth stunted, internodes and roots abnormally short, forming a dwarf plant. Vacuolate intracellular bodies, 3 to 10 by 2.5 to 8.5 microns in size, close to nuclei of cells in affected tissues.

Transmission: By leafhoppers, Nephotettix apicalis var. cincticens Uhler. N. bipunctatus Fabr., and Deltocephalus dorsalis Motsch. (CICADELLIDAE). Virus transmitted through some of the eggs but through none of the sperm of infected individuals of N. apicalis. Transfer from individuals thus infected through the egg to their progeny likewise demonstrated, even to the 7th generation. This is the only confirmed instance of transmission of a phytopathogenic virus through the eggs of an insect vector and is considered as evidence that the virus multiplies within the body of its vector as well as in its plant hosts. Incubation period in insect usually 30 to 45 days after first feeding on an infected plant, sometimes as short as 10 or as long as 73 days; nymphs from viruliferous eggs do not become infective until 7 to 38 (average 19) days after emergence. Transmission by inoculation of expressed juice has not been demonstrated. No transmission through seeds from diseased rice plants. No soil transmission.

Literature: Agati et al., Philippine Jour. Agr., 12, 1941, 197-210; Fukushi, Trans. Sapporo Nat. Hist. Soc., 12, 1931, 35-41; Proc. Imp. Acad., Tokyo, 9, 1933, 457-400; Jour. Fac. Agr. Hokkaido Imp Univ., 37, 1934, 41-161; Trans. Sapporo Nat Hist. Soc., 15, 1934, 162-165; Proc. Imp. Acad., Tokyo, 11, 1935, 391-303, 15, 1937, 328-331; 15, 1939, 142-145; Jour. Fac. Agr. Hokkaido Imp. Univ. 45, 1940, 53-151; Katsura, Phytogath. Transmission: By leafbopper, Cicadula bimaculata Evans (CICADELLIDAE) Literature: Schindler, Jour. Austral. Inst. Agr. Sci., 8, 1942, 35-37,

Genus VI. Fractilinea McKinney.

(Jour. Washington Acad. Sci., 54, 1944, 148.)

Viruses of the Stripe-Disease Group; hosts grasses; insect vectors, cleadellid and fulgorid leafhoppers Generic name from Latin, meaning interrupted and line.

The type species is Fractilinea maidis (Holmes) McKinney.

#### Key to the species of genus Fractilinea.

- I. Vectors, cicadellid leafhoppers.
- 1. Fractilinea maidis.
- 2. Fractilinea oryzae.
- 3. Fractilinea tritici.
  4. Fractilinea quarta.
- II. Vectors, fulgorid leafhoppers
- 5 Fractilinea zeae.
- 6. Fractilinea acenae.
- Fractlinea maidis (Holmes) Me-Kinney (Marmor maidis Holmes, Handb Phytopath Viruses, 1939, 56, Fractlinea maidis McKinney, Jour. Washington Acad Sci, 34, 1914, 149)
   From New Latin mays, corn (ie maize)

Common name: Maize-streak virus Hosts: GRAMINEAE—Zea mays L, corn (maize); Digitaria horizontalis Willd. Eleusine indica Gaert. Sac-

charum officinarum L , sugar cane.
Geographical distribution Africa

Induced disease. In corn, pole spots at base of young leaf, followed by chlorotte spotting and streaking of aubsequently formed leave. Virus moves rapidly (up to 40 cm in 2 hours at 20° C) after introduction into fiest plant by insect. More virus in chlorotte spots than in green areas of affected leaves.

Transmerion By helitoppers, Creation of Bellethalp which (Namels, C. tree China, and C. storey China, Cell. DELLIFIAE) in C. molta ability to transmit this virus is controlled by a servinked dominant gene, active male (AN) (Y), insertive male (AN) (Y), insertive male (AN) (X), active female (AN) (AN), active female (AN) (AN) or (AN) (AN). Insertive individuals ingest virus when feeding, but can become infertive only if the intestine

is wounded purposely or accidentally. If moculated artificially by introducing virus into blood, both active and inactive insects become infective. Incubation period, 6 to 12 hours at 30° C. Young not infected through the rgs. Infective leaf-hopper cannot transmit virus unless feeding plunture exceeds a minimum period, about 5 minutes in duration. This virus has not been transmitted to its plant hosts by inocultions of expressed juices.

Filterability . At pH 6, passes Cham-

berland I., and I., Berkefeld V. and N., filtera, retained by Seitz I. K. filter disc. Literature: Storey, Ann. Appl., Bool., 12, 1925, 422-439, 15, 1928, 1-25; 19, 1932, 1-25, 196, 196, 56, B. 1978, 435-477; Ann. Appl. Bool., 21, 1934, 588-589; 24, 1977, 87-91, Last Mr. Agr. Jour., 1, 1336, 471-475, Storey and McClenn, Ann. Appl. Bool., 12, 1936, 061-719

Strains: Two strains that differ radically from the type, var. typicum II, (loc cd, 50), have been given varietal names, as follows

la Fractilinea maidis var. sacchari II. (loc cit., 57) From New Latin Saccharum, generic name of sugar cane. Common name: Cane-streak strain of sect is usually between 11 and 23 days, although shorter periods have been demonstrated in a few cases. Virus may persist in the insect host until death, but may become exhausted earlier. Not by aphid, Aphis madds Fitch (APHIDI-DAE). Not by inoculation of expressed juice

Literature: Briton-Jones, Trop. Agr., 10, 1933, 119-122; Carter, Ann. Ent. Soc. Am., 54, 1941, 551-556; Kunkel, Bult. Hawaiian Sugar Planters' Assoc., Bot. Ser., 3, 1921, 44-57; 1924, 108-114; Hawaiian Planters' Rec., 26, 1922, 58-61; Phytopath., 17, 1927, 41 (Ast.); Stahl, Trop. Pl. Res Found., Bull. 7, 1927; Storey, Rept. of Plant Pathologist, Amani Agr. Res Station, 4th Ann. Reot., 1931-32, 20 8-33.

6. Fractilinea avenue McKinney (Jour. Washington Acad Sci., \$4, 1944, 327.) From Latin arena, oats

Common name: Pupation-disease virus.

Hosts: GRAMINEAE—Avena satira
L., oat; Triticum aestivum L., wheat;

Echinochloa crusgalli Beauv.; Setaria viridis; rarely, Arponyron repens (L.) Beauv. and Bromus inermis Leyss Experimentally, also Hordeum vulgare L., barley; Panicum miliaceum L., millet; Oryza zotica L., rice; Secale cereale L., tye; Zea mays L., corn (maire). Geographical distribution: West St.

Geographical distribution: West Siberia.

Induced disease In act, chloretic mottling, profuse development of shoots, profiferation of flowers with change to leaf-like structures. Protein crystals in affected cells have been regarded as necumulated virus.

Transmission: By leafhopper, Delphaz striatella Fallau (FULGORIDAE), especially first and second instar mymbis, fifth instar nearly immune to infection. Incubation period, 6 days or more. Virus overwinters in insect as well as in plants. Not transmitted from an infected leafhopper to its progeny. Not through soil. Not through seeds from infected plants with the progeny of the progeny. Not through seeds from infected plants

Literature: Sukhov et al., Compt. rend. Acad. Sci., U. R. S. S., 20, 1938, 745-748, 26, 1940, 479-482, 483-485. 22, 1936, 8SF-805; Takata, Jour. Japan Agr. Soc., 171, 1805, 1-4, 172, 1896, 13-22 (Takata's papers, in Japanese, constitute the first published record of transmission by an insect of a virus causing disease in a plant, the leafltopper Dellocephalus dorsalis Motsch, transmitting dwarf-dweeze virus to rice; see Fukushi, 1977, cited above).

3 Fractilinea tritici McKinney. (Jour. Washington Acad Sci., 54, 1944, 327) From Latin triticum, wheat

Common name. Winter-wheat mosaic

Hosts GRAMINEAE—Triticum aestieum L, wheat; Secale cercale L, rye, Arena byzantina; A. fatua L, wild oat, A. satina L, oat, Hordeum vulgare L, barley.

Geographical distribution Union of Soviet Socialist Republics.

Induced disease: In winter wheat and rye, chlorotic mottling; profuse branching. In winter wheat, phloem necrosis, chloroplasts few, senall; vacuolate inclusions in cells; nuclei enlarged and with extra nucleoli, no protein crystals of the puption-disease type in affected cells. In spring wheat, harley, and cats, chlorotic mottling without profuse branching, no proliferation of flowers, but grant is rarely formed, most infected plants dying before this stage of growth.

Transmission: By leafhopper, Delto cephalus strictus L. (CICADELLIDAE), with incubation period of 15 to 18 days. Not by inoculation of expressed juice. Not through soil

Laterature. Zazlurilo and Situakova. Compt rend. Acad Sci. U. R. S. S., 25, 1933, 798-801; 26, 1910, 474-478, 29, 1910, 429-432, Proc. Lenin Acad. Agr. Sci., U. R. S. S., 6, 1911, 27-27 [Rev. Appl. Myc., 19, 1910, 208; 20, 1911, 157, 396, 22, 1917, 29]

4 Fractilinea quarta (Holmes) comb nor (Varmor quartum Holmes, loc est , 65) From Latin quartus, fourth Common name: Sugar-cane chloroticstreak virus or fourth-disease virus.

Host: GRAMINEAE-Saccharum officinarum L, sugar cane.

Geographical distribution. Java, Queensland, Hawaii, Puerto Rico, Colombia, United States (Louisiana).

Induced disease 'In sugar cane, reduction of growth rate; willing at midday; long, narrow, longitudinal streaks, of creamy or white color, in the leaves Streaks 1/16 to 3/16 inches wide, generally less than 1 foot long, fragmenting.

Transmission. By leafliopper, Dracculacephala portola Ball (CICADELLI-DAE). Not demonstrated by inoculation of expressed juice.

Thermal inactivation: In cuttings, at 52° C in less than 20 minutes.

Literature: Abbott, Phytopath, 28, 1938, 535-537; Sugar Bull, 16, 1938, 3-4; Abbott and Ingram, Phytopath, 32, 1942, 99-100; Bell, Queensland Agr Jour., 40, 1933, 469-461; Martin, Hawauran Planters' Rec, 34, 1930, 375-378; Hawaiian Sugar Planters' Assoc. Proc, 63, 1931, 21-33.

5 Fractilines zeae (Holmes) comb. nor (Marmor zeae Holmes, loc. ett., 59.) From New Latin Zea, generic name for corn (maire), from Latin zea, a kind of grain

Common name Maize-stripe virus.

Host. GRAMINEAE—Zea mays L.,
corn (maize).

Insusceptible species GRAMINEAE

-Saccharum officinarum L, sugar cane.

Geographical distribution Hanni, Tanganyika, Mauritius, Trimidad, Cuba Not in United States

Indured disease. In corn (maire), at first few, clongsted, chlorotte brisins near base of young leaf, later enlarging and fusing to form continuous stripes. Sulfisquently formed leaves tanded and striped variously. Vaciolate: intracellular inclusions in cells of affected areas.

Transmission By leafliopper, Peregranus maidis (Ashm.) (FULGORI-DAE), the incubation period in this in-

- Found in nature principally in solanaceous plants; Cucurbilaceae insusceptible. Chlorotic mottling in some hosts, necrotic lesions in others as result of experimental infection. Suspensions show anisotropy of flow.
  - 1. Marmor tabaci.
    2. Marmor constans.
- Found in nature only in cucurbitaceous plants; Solanaceae insusceptible.
   Only mottling as result of experimental infection. Suspensions show marked anisotropy of flow.
  - 3. Marmor astrictum.
- III. Found only in leguminous plants. Chlorotic lesions in some varieties of the common snap-bean plant, necrotic lesions in others, as a result of expermental infection.
  - 4. Marmor laesiofaciens.
- Found in greenhouses confined to roots and lower parts of plants. Only necrotic lessons as result of experimental infection. Suspensions do not show anisotropy of flow.
  - 5. Marmor lethale.
  - V. Found in tomate and experimentally transmissible to a number of species of plants in this and other families. Resembling the preceding in a number of physical characteristics, including failure to show anisotropy of flow 5. Marmor dodecabetron.
- 1 Marmor tabact Holmes (Holmes, Handb Phytopath Viruses, 1939, 17; Museum tabact Valicau, Phytopath 5, 1940, 822; Phytopath 7, 1941, 23.) From New Latin Tabacum, early generic name for tobacco

Common names: Tobacco-mosaic virus, tomato-mosaic virus.

Hosts. SOLANACEAE—Neotiana tabacum L., tobacco; Lycopersicon esculentum Mill, tomato, and Capsicum fruisseens L., garden pepper, among crop plants; nearly all, if not all, solanaceous plants can be infected, although in some the virus remains localized at or near the site of inoculation PLANTAGINACEAE—A strain of this virus has been found in nature infecting Plantago lanefoldat L, ribgrass, P. major L. and rugelii Dene, common broad-leaved plantains. Experimental hosts are widely distributed through many related families of plants.

Geographical distribution: World-wide.
Induced disease: In most varieties of tobacco, yellowish-green primary lessons, followed by clearing of veins, distortion and greenish-yellow mottling of newly formed leaves. In Ambalema tobacco,

no symptoms, virus being restricted to inoculated leaves or those nearby. Strains of tobacco showing necrotic effects have been produced recently. In tomato, no obvious primary lesions, systemic disease characterized by greenishyellow mottling of foliage, moderate distortion of leaf shape, and a reduction of fruit yield not exceeding 50 per cent. If some strain of potato-mottle virus (Marmor dubium) is also present, a more severe disease is induced; this is known as double-virus streak, and is characterized by systemic necrosis. In most varieties of garden pepper, yellowish primary lesions followed by systemic chlorotic mottling In the Tabasco pepper and its recent derivatives, recovery by abscission of inoculated leaf, after localization of virus in necrotic primary lesions. Vacuolate intracellular inclusions are found in chlorotic tissues of all hosts that show distinct chlorotic mottling.

Transmission. By slight abrasive contacts By inoculation of expressed juice. To some extent by the aphilos, Myuso pseudosoland Theob., M. circumferus (Buckt), Macrosuphum solani/glai Abm. and Myuso persicae (Sult.) (APHIDI-DAE). By grafting. Through soil.

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FAMILY II. MARMORACLAE HOLMES EMEND

Viruses of the Mossie Group, inducing diseases usually characterized by persistent viruses of the Mossic Group, inducing diseases usually characterized by persistent chlorotic or necrotic spotting, and often by mottling. The family is here extended to enterouse or necrous sporting, and often by morting. Inc family is nere extended to include feveral small groups of viruses, formerly assigned independent family rank, include feveral small groups of viruses, formerly assigned undependent family rank, but sharing a tendency to aphid transmission, so far as known, and inducing diseases but sharing a tendency to aping transmission, so far as above, and indusing diseases, or dwarfing, characterized by abnormal growth habit, thickening and rolling of leaves, or dwarfing, cnaracterized my annormal growth about, thickening and roung of leaves, or ownting, traits not incompatible with the characters of the present group. Should any one of traits not incompatible with the characters of the present group. Should any one of these small groups become the center of a large assemblage of new virtues in the future, these small groups become the center of a large assemblage of new virues in the turne, separate familial status for it might again be advantageous. In the combined groupseparate tamulai status for it might again we advantageous. In the combined fing here used, specific vectors, so far as known, are aphids (APIIIDIDAE)

1 Viruses of the Typical Mosuc-Disease Group.

Genus I Marmor, p. 1163

II Viruses of the Spindle-Tuber Group Acrogenus, p 1202

III Viruses of the Leaf-Roll Group

Genus III. Corsum, p 1203 IV Viruses of the Dwarf-Disease Group

V Viruses of the Rough-Bark Group Rimocortius, P 1208

VI Viruses of the Symptomics Group. Adelonosus, p 1211 Genus VI

## Genus I Marmor Holmes

Viruses inducing typical moraic diseases in various plants Generic name from

Latin marmor, a mottled substance The type species is Marmor tabaci Holmes

A Relatively regutant to hest mactivation, usually requiring more than 10

minutes at \$5 to 90° (\* for complete mactivation It Relatively susceptible to heat macrination, requiring less than 10 minutes at

a Replacing pitalo-sembanding virus in mixed infections 2 Tobacco-Etch Virus Group

as Not replacing relato veinbuilding virus in mixed infections 3 Cucumber Moraic Virus Group. C. Many additional species cannot yet be grouped into definite subdivisions of

the genus, they constitute a residual or

Key to the species of the Tobacco Motoic Virus Group Viruses relatively resistant to less mactivation, requiring in most cases more than Vitues relatively resistant to lest inactivation, requiring in most execution to number of the following the follo under natural conditions

,, \$ ايبو فزار ٢,٠٠ Par.

Gelatin colonies: Smooth, soft, flat, spreading, entire, yellowish-green.

Gelatin stab: Growth along stab. Liquefaction with yellowish-white sediment.

Agar colonies: Circular, raised, smooth, amorphous, entire. Agar slant: Yellowish-white, moist,

glistening, becoming light green-fluorescent. Broth: Turbid, with yellowish-white

sediment. Litmus milk: Flocculent precipitation.

Slow peptonization with yellow scrum. Alkaline.

Potato: Dirty yellow to olive, most, glistening, entire.

Indole is formed.

Nitrates reduced to nitrates and ammonia. No gas formed

Aerobic, facultative Optimum temperature 22°C.

Source · Isolated from beer

 Pseudomonas septica Bergey et al. (Bacillus fluorescens septicus Stutzer and Wsorow, Cent. f. Bakt., II Abt., 71, 1927, 113; Bergey et al , Manual, 3rd ed., 1930, 169.) From Greek, septikos, putrefactive, septic

Rods 0 6 to 0 8 by 0.8 to 20 microns, occurring singly. Motile with a polar flagellum Gram-negative.

Gelatin stab Infundibuliform liquefaction.

Agar colonies: Circular with opalescent center and transparent periphery Agar slant Moderate, undulate margin.

Broth: Turbid with fragile pellicle, greenish in upper portion.

Litmus milk: Alkaline, coagulated Blood serum not liquefied

Acid from glucose. Aerobie, facultative.

Optimum temperature 20°C. Habitat: Dise\se of caterpillars

15 Pseudomonas boreopolis Gray and

Thornton (Gray and Thornton, Cent. f. Bakt., II Abt , 73, 1928, 74.) From Greek, boreas, the North wind; polis, city; M. L. North City. Rods: 0.5 to 1.0 by 2.0 to 3.0 microns.

occurring singly and in pairs. Motile with one to five polar flagella. Gramnegative.

Gelatin colonies: Liquefied.

Gelatin stab: Liquefied. Medium reddened.

Agar colonies: Circular or amoeboid, white to buff, flat to convex, smooth, glistening, translucent border.

Agar slant: Filiform, whitish, raised, smooth, glistening, fluorescent.

Broth: Turbid.

Nitrates reduced to nitrites. Starch not hydrolyzed.

Acid produced from glucose.

Attacks naphthalene.

Aerobic, facultative. Optimum temperature 20° to 25°C. Habitat: Soil.

Pseudomonas smaragdina Migula. (Bacillus smaragdinus foetidus Reiman, Inaug. Dissertation, Würzburg. 1887; Migula, Syst. d. Bakt., 2, 1900, 890.) From Greek, smaragdinas, green like the smaragdus, the emerald.

Small rods, occurring singly, Nonmotile. Gram-negative.

Gelatin colonies: Small, convex, irregular, whitish with greenish shimmer.

Gelatin stab: Slight surface growth. Infundibuhierm liquefaction. liquefied medium becomes light emerald green in color.

Agar colonies · Small, brownish-vellow,

Agar slant. Abundant growth with greenish fluorescence.

Broth: Turbid.

Litmus milk: Not coagulated.

Potato: Dark brown, becoming chocolate brown.

Indole not formed.

Nitrates not reduced.

The cultures give off an odor resembling jasmine.

Aerobic, facultative.

Through dodder, Cuscula competers Yuncker (CONVOLVULACEAE), without infecting this plant vector. Not through pollen from discased plants. Not through seeds from discased tobaccoseed transmission has been reported in the case of recently ripened seeds from diseased tomato.

Serological relationships: Precipitin test gives cross reactions between all known attrains, except those characterized by failure to spread systemically in to-barco. No cross reactions with other viruses except weakly with eucurbitmosaic virus (Marmor astrictum). Type and other strains of tobacco-mosaic virus give cross reactions in complement-fixation and neutralization tests

Immunological relationships: Plant protertion tests, particularly in Nectiona sylvatires Spegur and Comes, have demonstrated that tissues invaded by any strain of this virus are immune to subsequent infection by the tomato auculamosaic strain of tolarco-mosaic virus, indirecting a group relationship not shared by other viruses, such as cucumbermoraic virus or tolarco integrot virus.

Thermal mactivation At SS to 93° C in 10 minutes, at 86 to 92° C in 30 minutes. Filterability Tobacco mesaic virus was the first virus shown to be filterable, by Iwanowski in 1892, its filterability was

confirmed and interpreted by Benjerinek in 1898

Other properties. The ultimate particles of tobacco mosaie virus have been shown to be rod-shaped and sectropic, sometimes associated in pairs, and to end Under proper conditions, thread like paracrystals are formed. Specific gravity has been determined as about 1.37, refractive index as about 1 C. I welcetne mount between pH 3.2 and 3.5 Suspen soms in media of lower refrictive indices above anisotropy of flow. Sedimentation corstants, at 20° C, 187 × 10-11 cm per see per date at infinite dilution for unaggregated virus and 216 × 10-11 cm per see, per dyne for associated particles The computed average length of the virus unit is about 272 millimicrons: diameter. 13.8 millimicrons. Electron micrographs show that characteristic particles are rodlike, between 10 and 20 millimicrons in width, variable in length, but in some preparations averaging 270 millimicrops in length for single units, 405 to 540 millimicrons in length for associated pairs: X-ray measurements in air-dry cel show width 15 20 + 0.05 millimicrons Solutions stronger than about 1 3 per cent senarate into layers, the lower spontaneously doubly refracting and more concentrated than the upper. At concentrations of electrolytes somewhat less than are required to precipitate the virus as fibres or needle-shaped paracrystals, the solutions form clear cels that become fluid on shaking or diluting (at pH 7 and 30° C). The virus is destroyed by high-frequency sound radiation, by pressures between 6000 and 8000 kilograms per square centimeter, and by hydrogen ion concentrations above pH II or below pH I. It is relatively stable between pH 2 and pH 8 It is rapidly broken down in 6 M urea solutions, in the presence of salts, to low-molecular-weight compopents devoid of activity Analysis of purified virus earlion 47.7 per cent, hydrogen 7.35 per cent, nitrogen 15 9 per cent, sulfur 021 per cent, phosphorus 060 per cent, lipoid 0 0 per cent, carbolis drate 1.6 to 2 fi per cent A rexised estimate of the sulfur content is 0 20 per cent, probably all in eysteine, no methionine his been detected in the typical variety of this virus The percentages of the following substances in the virus are tyrosine 3.9. trantophane L5, proline 4 6, arginine 9 0. phenylalanine 60, serine 64, threonine 5.2, eysteine 0 68, alanine 2 4, aspartie neid 26, glutamic acid 5.3, leucine 61, valine 39, nucleic acid 5.8, and amide nurogen 19, collectively accounting for about to per cent of the total neight. Virus formation ceases in infected Lost tissues immersed in 0 0002 molar sodium transfe edution, beginning earin after removal of example.

Literature: The literature dealing with tobacco-mosaic virus is too voluminous to permit citation of more than a few representative publications. Allard, U. S. Dept. Agr., Bull. 40, 1914; Bawden and Pirie, Proc. Roy. Soc. London, Ser. B., 123, 1937, 274-320; Beale, Jour. Exp. Med , 54, 1931, 463-473; Beijerinck, Verhandel. Konink. Akad. Wetenschappen te Amsterdam, II, 6, 1898, 3-22; Grant. Phytopath., 24, 1934, 311-336; Hoggan, Jour. Agr. Res., 49, 1934, 1135-1142; Iwanowski, Bull. Acad. Imp. Sci. St. Petersburg, Ser. 4, 3, 1892, 67-70; Jensen, Phytopath., 23, 1933, 964-974; Johnson, Science, 64, 1926, 210; Kausche et al., Naturwiss., 27, 1939, 292-299; Knight, Jour. Biol. Chem., 147, 1913, 663-666; Kunkel, Phytopath , 24, 1934, 437-466; Lauffer, Jour. Am. Chem. Soc., 66, 1944, 1188-1194, Price, Phytopath., 25, 1933, 749-769; Stanley, Phytopath., 26, 1936. 305-320; Takahashi and Rawlins, Proc. See Exp Biol. and Med , 50, 1932, 155-157; Valleau and Johnson, Kentucky Agr. Exp. Sta., Bull. 376, 1937; Vinson, Science, 66, 1927, 357-358, Woods, Science, 91, 1940, 295-296

Stmins: A great number of variant strains have been isolated both experimentally and from plants infected in nature. These usually share with the type variety most of the fundamental properties, particle size, especially width, stability at relatively high temperatures, longevity in storage, some common antigens. The following have been distinguished from the type, var. vulgare H. (foc. ct. 17), by varietal names:

1a. Marmor tabaca var aucuba H. (loc cit, 20). A group of isolates producing mecrotic local lesions in inoculated leaves of Nicotiana sylvestris Spegaz. and Comes; useful in identifying many other strains of this virus which on prior application protect the tissues of this plant from the nerotic effects of aucuba-type strains (Smith, Ann. Appl. Biol., 18, 1931, 471-493; Kunkel, Phytopath., 24, 1934, 437-466).

 Marmor tabaci var. deformans H. (foc. cit., 22). Producing exceptionally severe malformation of tomato foliage. (Ainsworth, Ann. Appl. Biol., 24, 1937, 515-550).

ic. Marmor tabaci var. canadense H. (loc. cit., 23). Producing a necrotic type of streak disease in tomatoes (Jarrett, Ann. Appl. Biol., 17, 1930, 218-259).

1d. Marmor tabaci var. lethale H. (loc. ctl., 24). Producing spreading necrotic lesions in tobacco and tomate under experimental conditions (Jensen, Phytopath., 27, 1937, 00-84; Norval, Phytopath 28, 1938, 676-692).

le. Marmor tabaci var. planlaginis H. (Phytopath., 31, 1911, 1907). Specially ndapted in nature for systemic spread in species of Planlago. This variety contains histidine (0.55 per cent) and methionine (2 per cent) not found in the type of the species.

11. Marmor tabacı var. obscurum H. (Handb. Phytopath. Viruses, 1939, 25). Systemic in tobacco without producing obvious disease under experimental conditions (Holmes, Phytopath., 24, 1934, 845-873; 26, 1936, 896-904; Jensen, Phytopath., 27, 1937, 69-84).

ig Marmor tabacs var. immobile II. (loc. cit, 26). Produces chicortic primary lesions in experimentally infected tobacco, but rarely becomes systemic. (Jensen, Phytopath., 23, 1933, 964-977; 27, 1937, 69-84).

1h. Marmor tabaci vat. artum H. (loc cit., 27) Necrotic lesions experimentally induced in Nicotiana glutinosa L. (SOLANACEAE) are much smaller than those of the type variety (Jensen, Phytopath., 27, 1937, 69-84).

 Marmor tabaci var. siccans Doolittle and Beecher. (Phytopath., 32, 1942, 391). Causing necrosis and shriveling of tomato foliage. 2. Marmor constans McKinney (Jour. Washington Acad Sci., 54, 1944, 326.) From Latin constant, fixed.

Common name, Tobacco mild darkgreen mosaic virus

Hosts SOLANACEAE-Nicotiana

Insusceptible species. SOLANA-CEAE—Lycopersicon esculentum Mill, tomato CUCURBITACEAE—

Cucumis saticus I., cucumber Geographical distribution Islands of Grand Canary and Teneriffe

Induced disease In Nicotiana glauca,

systemic chlorotic mottling
Transmission By inoculation of expressed juice No insect vector is

known
Thermal inactivation At about 86°C

in 10 minutes
Literature McKinney, Jour Agr
Res 29, 1929, 557-578, Am Jour
Bot. 28, 1911, 770-778, Peterson and
McKinney, Phytopethi. 28, 1938, 329312, Thornberry and McKinney, tbid. 29, 1939, 250-250

3 Marmor astrictum Holmes (Holmes, Hindb Phytopath Viruses, 1933, 37; Musicum astrictum Valleru, Phytopath, 50, 1910, 823) From Latin astrictus, limited, in reference to host ringe.

Common names: Cucurbit-mo-aic

Hests CUCURRITACEAE—Cucumis solirus L., cucumier, C. onguria L., glerkin, C. rielo L., melon, Citrullus rulgaris Schrid., watermelon; only cucurintareous plants have appeared to be susceptible thus far.

Insuceptible species All tested selataccos, species CUCURBITA-CT 1F--Bryonia dioca L.; Cucurbita pipa L., secitable marrow. LEGU-ULNOSAE-Platrolus sulparis L. var Golden Cluster

Geograp' leal distribution. Hegland. Induced discuse. In cucumber, clearing of some and crumpling in young leaves, followed by agreen merale metaling, with blistering and distortion of newly formed leaves. Plant stunted. Fruit unmarked or slightly mottled. Diseased plants less obviously affected during winter months.

Transmission By inoculation of expressed juice No insect vector is known.

Serological relationships: Weak cross precipitin reactions and full cross-neutralization reactions with tobacco-mosaic virus (Marmor tabaci). Two common antigens postulated Preparations of virus that have been mactisated by treatment with nitrous acid or X-rays are still automic.

Thermal inactivation · At 80 to 90° C in 10 minutes.

Filterability: Passes Pasteur-Chamberland filters La to La, and membranes of 150 millimicrops average pore diameter. Other properties. Virus, infectious in dilution of 10-14, is present to the extent of 0.2 to 0.3 gram per liter of juice from diseased plants. Preparations show sheen and anisotropy of flow, indicating rod-shaped particles Solutions stronger than 2.5 per cent separate into 2 layers at room temperature, the lower being the more concentrated and birefringent, Precipitates with ammonium sulfate show needle-shaped paracrystals. Sedimentation constants Sps = 173 × 10-11 cm sec ~1 dyne=1 and about 200 × 10-13 cm. sec." dyne". Virus withstands drying without inactivation but with partial loss of ability to show anisotropy of flow and with reduction of ecrological activity to about half Tryptoplane content 1.4 per cent. plenylalanine 10.2 per cent. the first lower and the second higher than in tolorco-mossic virus.

Literature: Amoueth, Ann. Appl. Biol. 22, 1035, 56-7; Dwiden and Pine, Nature, 129, 1937, 546-517; Brit. Jour Exp. Buth. 18, 1937, 275-291; Knight, Arch. Virud. 4, 1942, 296-297; Knight, and Stanley, Jour. Biol. Chem., 111, 1941, 29-39; Jill, 199-49; Pine, Am. Jour. Biol., 37, 199, 539-541; Prace and Wyc. Inf., Nature, 111, 1938, 563.

Strains: A distinctive strain has been distinguished from the type, var. chlorogenus H. (loc. cit., 27), by the varietal name:

3a. Marmor astrictum var. aucuba II. (loc. cit., 22). Differing from the type of this species by inducing a yellow-mottiing, rather than a green-mottling, measie in eucumber (Ainsworth, Ann. Appl. Bool., 22, 1935, 55-67).

 Marmor laesiofactens Zaumeyer and Harter. (Jour. Agr. Res., 67, 1943, 305.)
 From Latin laesio, substantive from laedere, to injure, and participle from facere, to make.

Common name: Bean-mosaic virus 4; southern bean mosaic virus 1.

Hosts: LEGUMINOSAE—Phascolus vulgaris L., bean. Experimentally, also Phascolus functus L., sieva bean; Soja max Piper var. Virginia, Virginia soy bean.

Insusceptible species: All tested species in families other than the LEGU-MINOSAE.

Geographical distribution: United States (Louisiana).

Induced disease: In bean, systemic chlorotic mottling in some varieties. localized necrosis in others; in a few varieties, systemic necrosis In mottling-type varieties, chlorotic mottling of foliage; pods marked by dark green blotches or shiny areas, slightly malformed, short, frequently curled at end-In necrotic-type varieties with localized response, bearing a dominant gene lacking in mottling-type varieties, reddish necrotic lesions at the site of inoculation; no evidence of systemic spread of virus. In varieties showing systemic necrosis, pinpoint or slightly larger necrotic primary lesions with veinal necrosis of inoculated leaf; systemic veinal necrosis, distortion and curling of affected leaves, drooping at the pulvint, stem and petiole streak; eventual death of plant.

Transmission: By inoculation of expressed juice. Through seeds from infected plants. Serological relationships: Not demonstrated.

Immunological relationships: Previous infection with bean-mosaic virus, Marmor phaseals, does not protect against infection with this virus.

Thermal inactivation: At 90 to 95° C, time not stated, probably 10 minutes.

Other properties: Withstands dilution of

to,...., 34, 1944, 510-512; Jour. Agr. Res., 67, 1943, 295-300, 305-328.

Strains: A strain differing from the type has been given the varietal name:

4a. Marmor lacstofaciens var. minus Zaumeyer and Harter. (Jour. Agr. Res., e7, 1913, 305.) From Latin minor, lesser. Differing from the type by inducing formation of slightly less diffuse and spreading lesions in necrotic-type bean leaves; also by inducing milder early symptoms and more severe late symptoms in mottling-type beans. Passes through

5. Marmor lethale H. (loc. cit, 86).

us.

ina tabacum L., tobacco, A. y. .. langsdorfii Weinm.; Lycopersicon esculentum Mill., tomato: Solanum nigrum L. COMPOSITAE-Aster. GERANI-ACEAE-Pelargonium hortorum Bailey. LEGUMINOSAE-Phaseolus sulgaris L., bean. Confined to roots of these natural hosts except in the cases of Nicottana tadacum and N. glutinosa in which lower leaves are sometimes invaded; necrotic fesions along midnib and larger veins in these. No obvious manifestations of disease in infected roots. Experimentally to plants in many families with production of localized necrotic

lesions only.

Geographical distribution: England. Scotland, Australia. This virus has been found only in greenhouses.

Induced disease; In tobacco, necrosis of midrib and larger veins of first-developed pair of leaves, between November and February. Virus also in roots of many healthy-looking plants throughout the year. Upon artificial inoculation of foliage, numerous small brown necrotic local lesions are produced. Yield of virus from infected plant 0 02 mg per cc of expressed juice, on the average,

Transmission . By contamination of soil with virus. No insect vector is known. Experimentally, by inoculation of expressed juice.

Serological reactions: Precipitates with homologous antiserum. No crosa reaction with tomato bushy-stunt or tobacco-

mossie viruses Immunological relationships: Protection tests show lack of relationship to tobacco-mosaie virus, tobacco-ringspot virus, tomato-ringspot virus, eucumbermosaic virus, and the severe-etch strain

of tobacco-etch virus.

Thermal inactivation: At 90 to 92° C in 10 minutes. Filterability: Average particle diame-

ter 20 to 30 millimurrons as determined by filtration through Gradocol membranes; other reports give diameter as 13 to 20 millimerons by filtration (14 to 19 millimicrons by radiation experiments, about 20 millimicrons from electron micrograpia).

Other properties. Infectious after stor-

are for months in dried leaves and after storace for half a year in absolute othal alcohol at mom temperature. Specific

gravity 1.3 More soluble in ammonium sulfate relations at 0° C than at room temperature. Composition. Carlson 41 9 to 45.3 per cert, nitrocen 13.5 to 16.5 per cent, hydrogen 6.5 to 7.0 per cent, phosplares 14 to 17 per cent, sulfur 1.1 to 20 per cent, carboby drate 7 0 to 9 0 per cent, ash 55 to 70 per cent (3 to 5 per cent after probaged didyris at pH 3) Nucleir soid of the place type has been isolated. No anisotropy of flow in solution but crystals are birefringent, showing sharp extinctions parallel to, and at right angles to, the plane of the crystal when examined edge-on in a polarizing microscope. Sedimentation constant, Smo = 112 X 10-11; in other preparations a crystalline component with sedimentation constant 130 × 10-11 and an amorphous component with sedimentation constant 58 × 10-11 have been reported. as well as small amounts of a substance with sedimentation constant 220 × 10-11.

Strains: Isolates of tobacco-necrosis virus serologically distinct but not otherwise different from each other appear to imply the existence of several strains of this virus, or of a closely related group of

viruses, in England.

Literature · Bawden, Brit, Jour, Exp. Path , 22, 1911, 59-70; Bawden et al., ibid . 25, 1912, 314-328; Cohen, Proc. Soc. Exp. Biol. and Med , 48, 1911, 163-167; Lea, Nature, 146, 1910, 137-138; Pirie et al , Parasitol , 50, 1938, 513-551; Price. Am. Jour. Bot . 25, 1938, 603-612; Am. Jour. Bot , 27, 1910, 530-511; Arch. Virust , 1, 1910, 373-386; Price and Wyckoff, Phytopath , 29, 1939, 83-91; Smith, Parasitol , 29, 1937, 70-85; 29, 1937, 86-95; Smith and Bald, Parasitel., 27, 1935, 231-215; Smith and MacClement, Parasitol , 32, 1910, 320-332

5a. Marmor dodecahedron II. floc. cit . 30). From Greek didekahedron, disternhedma

Common name. Tomate bushy-stunt sirus

Hosts · SOLA NACEAE-Lycoperateon esculentum Mill , tomato Experiment. ally, also SOLANACEAE-Daturg stramonium L ; Nicotiana glutinosa L ; N. langedorfie Weinm ; N. labacum I., to-Incar; Solinum nigrum L. LEGU-WINOSAI'-Placeolus culparu L. bean. Vigna sinches (L) Endl, cowpea. COMPOSITAE-Zinnia elegans Jacq., sunnia

Geographical distributions Britist. Islac.

Induced disease: In tomato, some primary lesions necrotic, ring-like or spot-like, others masked, or disclosed only by chlorophyll retention in yellowing leaves. In young plants, systemic necrotic lesions may cause death; in older plants, growth ccases, young leaves become pale yellow; growing points may die. inducing growth of axillary buds to produce a bushy top; older leaves become yellowed and show some purple coloration. In White Burley tobacco, local necrosis only, lesions small, red at first, . then white. In cowrea, reddish necrotic primary lesions only.

Transmission: By inoculation of expressed inice. Through dodder, Cuscuta campestris Yuncker (CONVOLVULA-CEAE). Not through seeds of diseased plants. No insect vector is known.

Serological relationships: A specific antiserum, prepared by a single intravenous injection of rabbits with 2 mg of purified virus, gives granular, compact precipitates, serving for quantitative estimation of this virus, antiserum being used at dilutions of 1:200 or 1:800, virus at dilutions to 10-6.

Immunological relationships. Will infeet plants previously invaded by tobacco-mosaic virus, tomato spotted-wilt virus, tobacco-ringspot virus, and Bergerac-ringspot virus.

Filterability: Passes membranes down to 40 millimicrons average pore diameter

Other properties: Virus crystallizes from solutions of ammonium sulfate as isotropic, rhombie dodecahedra, which shrink and swell reversibly on drying and

rewetting: shrinkage reduces size to 80 per cent of the wet dimensions. In the presence of heparin, non-birefringent prisms, rather than dodecahedra, appear. S. = 132 × 10-11 cm, sec. 1 dyne 1. Particle approximately spherical, 27.4 millimicrons in diameter by X-ray measurements (average diameter by filtration data, 14 to 20 millimicrons). Solutions do not show anisotropy of flow, Inactivated by drying. Molecular neight Density 1.353. Molecular 8.800.000. weight may be as high as 21,000,000 in solution, but the density is then lower, 1.286. Analysis : carbon 47 to 50 per cent, nitrogen 15.8 to 16.4 per cent, phosphorus 1.3 to 1.5 per cent, ash 1.7 to 5 per cent, hydrogen 7.2 to 82 per cent, sulfur 04 to 0.8 per cent, carbohydrate 5 to 6 per cent.

Literature: Ainsworth, Jour. Ministry Agr., 45, 1936, 266-269 : Bawden and Pirie, Nature, 141, 1938, 513; Brit. Jour. Esp Path., 19, 1938, 251-263; Bernal and Fankuchen, Jour. Gen. Physiol., 25, 1911, 111-165, Bernal et al., Nature, 142, 1938, 1075; Cohen, Jour. Biol. Chem. 144, 1912, 353-362; Proc. Soc. Exp. Biol. and Med, 51, 1942, 104-105; Lauffer, Jour. Phys. Chem., 44, 1940, 1137-1146; Lauffer and Stanley, Jour. Biol. Chem., 155, 1940, 463-472; Neurath and Cooper, Jour. Biol. Chem., 155, 1940, 455-462; Smith, Nature, 135, 1935, 908; Ann. Appl. Biol , 22, 1935, 731-741; Jour. Roy. Hort. Soc., 60, 1935, 448-451; Smith and MacClement, Parasitol., 55, 1941, 320-330; Stanley, Jour. Biol. Chem., 185, 1940, 437-454.

Key to the species of the Tobacco-Etch Virus Group.

Viruses -alervolv susceptible to heat inactivation (inactivated at 52 to 58° C in 10 group; dominant member minutes) other, if

1. . of the group in tobacco.

6 Marmor erodens. II. Replaced by No. 6, not by No. 8, if in mixture with it in tobacco.

III. Replaced by No. 6 or 7 if in mixture with either in tobacco.

 Marmor erodens Holmes. (Holmes, Handb. Phytopath. Viruses, 1939, 40;
 Foliopellis erodens Valleau, Phytopath.,
 50, 1940, 825) From Latin erodere, to erode or gnaw away.

Common name: Tobacco-etch virus frutes: SOL-1NACEAE—Capsicum frutescens L., pepper; Datura stramonium L., Jimson weed; Lycopersicon esculentum Mill., tomato, Nicotiana labacum L., tolucco, Petunia sp., potunia; Physalis

heterophylla Necs

Geographical distribution: United States. Induced disease: In tobacco, systemic

induced disease: In fortice, systemic mid-mottling chlorosis, with traces of necroite etching; intranuclear erystalline nuclusions and intracytoplasmic granular and amorphous inclusions that tend to crystallize, forming needle-shaped birefringent bodies, 2 to 10 microns in length

Transmission: Experimentally, by Myzus persicae (Sulz), M. ereimfezus (Buckt), Aphis rhamin Boyer, A fabae (Scop.), and Macrosiphum gei (Koch) (APHIDIDAE), by inoculation of expressed unce

present jure.

Serological relationships: Precipitin reactions with homologous antisera, butno cross-reactions with abacco-measurvirus, tolkacco-innegot virus, potatomotile virus, polato-aurula-measurvirus, potato-aurula-measurmeasur-virus, potato-aurula-measurmeasur-virus, potato-aurula-measurmeasur-virus, potato-aurula-measurmeasur-virus, potato-aurula-measurvirus, or usen measir-virus.

Immunological relationships: Protects tolerco against subsequent infection by postate resultanding siras and hypergrams mossic virus. In mixed infections, it suppresses and replaces these two viruses.

Thermal inscination At 53 to 55° C in

10 minutes

Littershilty Preses Pasteur Chamberland La, not La, filter candle

Other properties. Sedimentation constant Sn° = 170 × 10. 12 cm sec. 4 dynest, Concentrated proporations show anisatrupy of flow, in heating characted particle share.

Laterature Banden and Bassanis, Ann

Appl. Biol., 28, 1941, 107-118; Fernow, Cornell Agr. Exp. Sta. (1thaca), Mem. 96, 1925; Holmes, Phytopath, 32, 1942, 1058-1067; Johnson, Kentucky Agr. Exp. Sta. Res. Bull. 306, 1930.

Strains: A distinctive severe-symptom strain, isolated from plants infected in nature and studied intensively, has been distinguished from the type, var. rulgare II. (loc. cit, 40), by the varietal name:

6.1 Marmor erodens var. severum II. (loc ett., 41) Differing from the type by a tendency to induce more pronounced necrotic etching and a greater stunting effect in infected tobacco.

Marmor hyoscyami spec. nor.
 Prom New Latin Hyoscyamus, genus name of plant from which this virus was first isolated

Common names: Hyoseyamus-mosaic virus, Hy. III virus, Hyoseyamus-IIIdisease virus.

disease virus.

Hosts: SOLANACEAE--Hyoseyamus
niger L., henbane Experimentally, also

Nicotiana tabacum I., tobacco.
Insusceptible species .CUCURBITACEAE—Cucumis saticus I., cucumber.

Geographical distribution. England. Induced disease. In henkine, chlorotic clearing of veins followed by yellow-motthing mosuic

Transmission By inoculation of expressed junc to dilutions of 10%. By aphids, Myctis persion (Sult.), If circumfiexus (Buckt.), and Macrotiphum solanifolis Ashm. (= W get Koch) (APHIDIDAE).

Secological relationships. Several isolates of this write give mutual crossprecipital resetions but no precipitation occurs when antiserum prepared with this arms is mixed with enumber mosaic arms, tobacco-etch arms, or potato yeinbanding virus.

Immunological relationships: No immunity with respect to this virus is induced in tolarco by previous infection with execumber receive virus. Putatoventhening virus is unable to multiply in the presence of this virus and is replaced by it. Tolarco-eith virus proplaced by it. Tolarco-eith virus pro-

tects against this virus and replaces it in mixed infections.

Thermal inactivation: At 58° C in 10 minutes.

Filterability: Passes Chamberland La, but not La, filter candles.

Other properties: Concentrated solutions show anisatropy of flow. Yield of virus, 1 to 3 mg per liter of juice expressed from diseased tobacco plants.

Literature: Bawden and Kassanis, Ann. Appl. Biol., 28, 1941, 077-118; Hamilton, bid., 19, 1932, 550-567; Sheffield, ibid., 25, 1933, 781-789, Watson and Roberts, Proc Roy Soc London, Ser. B, 127, 1939, 543-576.

8. Marmor upsilon comb nos. (Marmor cucumers var-upsilon Holmès, toc. ct., 33; Murialba renataenta Valleau, Phytopath., 30, 1910, 821.) From Greek name of the letter Y, sometimes used to denote this virus

Common names. Potato-veinbanding virus, potato virus Y

Hosts: SOLANACEAE—Solanum tuberosum L., pointo, Nicoliana labacum L., tobacco Experimentally, also Lycium barbatum L.

Geographical distribution: England, France, United States, Brazil. Rare in Scotland and part of Ireland

Induced disease. In some potato varieties, leaf drop and necrotic stem-streak; in others, no signs of disease; in still others, chlorotic mottling with or without necrosis. In combination with strains of the potato-mottle virus (Marmor dubium), this virus causes rugose mosaic, a common and destructive double-virus disease.

Transmission: By inoculation of expressed juice. By aphid, Myrus persicae (Sulz.); experimentally, also by Aphin rhamni Boyer (synonym for Aphie ebrevata Patch) (APHIDIDAE).

Serological relationships: The pipin reactions with homologous antisers. No
eroes reactions with tobacco-mossie wrus,
tobacco-tech virus, hyoseyamus-mossue
virus, potato-mottle virus, potato mildmosaie virus, potato ancuba-mossie virus,
tobacco-ringspot virus, or common peamosaic virus. Reported cross reaction
with the unumber-mosaic virus needs confirmation.

Immunological relationships: A mild strain protects against subsequent infection with the typical virus. This virus is suppressed and replaced by hyoseyamus-mosaic virus and by tobacco-etch virus in mixed infections.

Thermal inactivation: At 52° C in 10

Filterability: Passes with difficulty through Gradocol membrane of 42 millimicron average pore diameter.

Other properties: Inactivated by dry-

Ing.
 Literature: Dennis, Nature, 142, 1933,
 154; Johnson, Phytopath., 25, 1933,
 150-562; Jones and Vincent, Jour. Agr. Res., 55, 1937, 60-79; Kassanis, Ana Appl. Biol., 29, 1942, 95; Koch. Phytepath., 25, 1933, 319-342; Kramer and Siberschmidt, Arquivos Inst. Biol., 526
 Paulo, Brazil, 11, 1940, 165-183, Salman, Nature, 153, 1937, 924; Smith, Proc. Roy
 Soc., Scr. B, 109, 1931, 251-267; Smith and Dennis, Ann. Appl. Biol., 27, 1940, 65-70

Key to the species of the Cucumber-Mosaic Virus Group.

Viruses relatively susceptible to heat inactivation, requiring less than 10 minutes at 85 to 90° C for complete inactivation. Not replacing potato-veinbanding virus in mixed infections

- I. Infecting both dicotyledonous and monocotyledonous plants.

  9. Marmor cucumerts
- II. Infecting dicotyledonous, but not monocotyledonous, plants
  - 10. Marmor solani. 11. Marmor aucuba.
  - 12. Marmor umbelliferarum.

- 13. Marmor cruciferarum.
  - 14. Marmor brassicae
  - 15. Marmor beine.
  - 16. Marmor lactucae. 17. Marmor dahlage.
  - 18. Marmor phaseols.
  - 19. Marmor leguminosarum,
  - 20. Marmor visi
  - 21. Marmor medicagins.
- III. Infecting monocotyledonous, but not dicotyledonous, plants.

  - 22. Marmor tulipae.
  - 23. Marmor mile.
  - 21. Marmor srides
  - 25. Marmor sacchars.
  - 26. Marmor cenae
  - 27. Marmor scillearum.
- 9. Marmor cucumeris Holmes (Holmes, Handb, Phytopath, Viruses, 1939, 31; Murialba cucumeris Valleau, Phytopath , 50, 1910, 823.) From Latin cucumia, encumber.
- Common Cucumber-mosaic name. virus
- Hosts Very wide range of hosts among dicotyledonous and monocotyledonous plants, encumber, celery, spinach, toincro, and pepper are sometimes seriously Overwintering hosts are SOL-ANACIAE-Physolis subglabrata Mackenzie and Bush, I' heterophylla Nees ASCLEPIADACEAE-Asclepias suri aca L. PHYTOLACCACEAE-Phyto locea decandra L. LABIATAE-Nepria cataria L. Probably there are also other susceptible perennials
- Geographical distribution Probably al most until unde Induced disease. In encumber, Cucu
- rus saturus I., Jellowish preen systemic lence small, distorted. motthre curled, plants dwarfed, interpodes shortened Few fruits set. Pruits mottled, mustagen, giving the disease the name "whate pickle " In black cowpey, Viona amenera (L.) Undl , small reddish pr erotic local lessons only. No intracellular ledies are found in plants infected with cucumber movie virus

Transmission By ineculation of expresed juice. By aphi le, Marus persieas (Fulz.), M. preudosciani Theob., M.

circumflexus (Buckt.), Macrosiphum solanifolis Ashm , and Aphis gossums Glov. (APHIDIDAE). Through seeds of diseased plants in Echinocystis lobata (Michx.) Torr and Gray, wild encumber, in Cucumis melo L. muskmolon, and in Cucurbita pepo I., vegetable marrow. By several species of dodder, Cuscuta californica Choisy, C. campestria Yuncker, and C. subincluse Dur and Hile (CONVOLVULACEAE)

Immunological relationships, Infection with the type and other chimotic-mottling strains protects rinnia seainst subsequent infection by an indicator atrain of this virus (var sudicis)

Thermal mactivation At 70 to 80° C in 10 minutes

Filterability · Preses Berkefeld W and N filters and collodion membranes of 45 trallimateron average pore diameter

Other properties. Inactivated by drying or 3 to 4 days' storage in juice at room temperature

Literature Amsworth, Ann Appl. Biol , 25, 1938, 867-869, Chamberlain, New Zealand Jour Science and Techpology, 21, 1939, 73 \-90 \. Celino, Philippine Agr., 23, 1910, 379-114, Deputtle, Phytopath , 6, 1916, 145-147; U. S. Dept. Agr., Bull 879, 1929, Doolattle and Walter, Jour. Agr Res., \$1, 1925, 1-58; Gilbert, Phytopath , C, 1916, 143-144; Il gran, Jour Agr. Hee , 47, 1933, 600-701, Jagger, Phytopath , 6, 1916, 148-151;

8, 1918, 32-33; Kendrick, Phytopath., 24, 1934, 820-823; Mahoney, Proc. Am. Soc. Hort. Sci., \$32, 1935, 477-480; Price, Phytopath., 25, 1935, 776-789; 29, 1939, 903-905; Am. Jour. Bot., 27, 1940, 530-541; Storey, Ann. Appl. Biol., 26, 1939, 298-308.

Strains: Various host plants seem to have induced specialization of eucumbermosaic virus in strains particularly adapted to existence in their tissues. Several of these and certain laboratoryderived strains useful in technical procedures have been distinguished from the type, var. vulgare H. (loc. cit., 31), by varietal names, as follows:

- 9a. Marmor cucumeris var. commelinae H. (loc. cit., 35). From New Latin Commelina, generic name of weed serving as a natural reservoir of this strain. Common name: Southern celery-mosaic strain of cucumber-mosaic virus. Differing from the type in severity of disease induced in celery and some other plants. Transmitted by Aphis gossypii Glov., A. maids Fitch, and Pentalonia nigronerrosa Con. (APHIDIDAE). (Price. Phytopath , 25, 1935, 947-954; Wellman, ibid., 24, 1934, 695-725, 1032-1037. 25. 1935, 289-308, 377-404.)
- 9b Marmor cucumeris var. phaseoli H (loc cit, 36). From New Latin Phaseolus, generic designation of lima bean. Common name: Lima-bean strain of cucumber-mosaie virus Differing from type of species in ability to cause a chlorotic mottling disease in lima bean in nature. (Harter, Phytopath., 26, 1936, 94, Jour. Agr. Res , 56, 1938, 895-906, McClintock, Phytopath., 7, 1917, 60.)
- 9c. Marmor cucumeris var. Islii H. (loc. ctt , 37). From Latin hlium, hly. Common name : Lily-mosaic strain of cucumber-mosaic virus Differing from the type variety by ability to persist in nature in lilies, producing masked infection or chlorotic mottling unless in mixture with lily-symptomiess virus (Adelonosus lilii), when a more severe disease involv-

ing necrosis is induced. (Brierley, Phytopath., 29, 1939, 3; 50, 1940, 250-257, Brierley and Doolittle, abid., 50, 1910. 171-174; Ogilvie and Guterman, thid., 19, 1929, 311-315; Price, ebid. 27, 1937. 561-569.1

9d. Marmor cucumeris var. judicis II. (loc. cit., 38). From Latin judez, judge. Common name: Indicator strain of cucumber-mosaic virus. Differing from the type variety in inducing the formation of necrotic local lesions in zinnia (Zinnia elegans Jacq., COMPOSITAE). Previous infection of zinnia by other strains of cucumber-mosaic virus inhibits the formation of these necrotic local lesions, identifying the strains as related to each other and to the indicator strain. (Price, Phytopath, 24, 1934, 743-761; 25, 1935, 776-789.)

9e. Marmor cucumeris var. rignae II. (loc. cit., 39). From New Latin Vigna, generic name of cowpea. Common name: Cowpea-mottling strain of cucumbermosaic virus. Differing from the type variety in producing systemic chlorotic mottling, rather than reddish-brown recrotic local lesions, in Black couper Not known in nature but derived experimentally from a mild-mottling strain of eucumber-mosaic virus during serial passage in cowpea. (Price, Phytopath, 24, 1934, 743-761; 25, 1935, 776-787)

10. Marmor solani H (loc. cit , 47). From New Latin Solanum, generic name of potato.

Common names: Potato mild-mo-aic

virus, potato virus A.

Hosts: SOLANACEAE -- Solanum tuberosum L., potato. Experimentally, also Nicoliana tabacum L., tobacco; Solanum nigrum L. var. nodiflorum; and Datura stramonium L., Jimson weed.

Geographical distribution: United States, England, Holland.

Induced disease: In potato, very mild chlorotic mottling or masked symptoms in some varieties (as Irish Chieftain), systemic necrosis in others (for example,

Optimum temperature 37°C.

Subcutaneous and intravenous moculations into rabbits cause death in 36 to 48 hours.

Source: Isolated from nasal secretions in orena.

17. Pseudomonas chlorina (Frankland and Frankland) Levine and Soppeland (Bacillus chlorinus G. and P. Frankland, Philos. Trans. Roy. Soc London, 173, 1887, 274; Bacterium chlorinum Migula, Syst. d. Pakt., 2, 1900, 471, Levine and Soppeland, Bul. No. 77, Iona State Agricultural College, 1926) From Greck, Philos. greenish vellow.

Rods: 0.5 by 1.5 micron, occurring singly and in short chains. Non-mottle. Gramnerative.

Gelatin stab. Crateriform liquefaction with green fluorescence. Lemon yellow sediment.

Agar colonies: Circular, raised, amooth, amorphous, entire, becoming greenish yellow.

Agar slant Slightly raised, glistening, the medium becoming light greenish vellow.

Broth Moderate turbidity Dirty yellow sediment No pellicle Litmus milk; Peptonized Litmus re

Litmus milk: Peptonized Litmus reduced.
Potato: Scant, olive green growth

Indole formed, Nitrites produced from natrates

Starch hydrolyzed.

Blood serum fiquefied in 5 days
Arid from glucose
Aerobie, facultative
Optimum temperature 22°C

Source: Air.

18. Pseudomonas ofeovoraus Lee and Chandler. (Jour Bact, 41, 1911, 378.) From M. I. oil destroying Short rods, 0.5 by 0.8 to 1.5 microns.

occurring singly and in pairs. Matile Gram-negative

Gelatin state: No liquefaction after 6 weeks.

Gelatin colonies: Up to 1 mm in diameter, fluorescent, similar to agar colonies.

Surface agar colonies: After 24 hours 1 to 2 mm. in diameter, smooth, convex, shiny, opaque, creamy, fluorescent by transmitted light Edge entire in young colonies.

Deep agar colonies: 0 5 by 10 to 15 mm, lens-shaped, buff-colored, not fluorescent

Agar slant Growth raised, smooth, fluorescent, edge erove

Broth After 24 hours moderate turbidity with slight yellowish viscid sediment. No pellicle or ring.

Litmus milk. No change

Indole not formed Potato: Good growth

Nitrites are produced from nitrates

Starch is hydrolyzed No acid from glucose, lactose, sucrose,

galactose, vylose, mannitol, salicin and

Equally good growth at 25° and 37°C.

Distinctive character. The fluorescent quality of the colonies is not imported to any of the artificial media used.

Source Isolated from cutting compound (oil-water emulsion) circulating in a machine shop. The oil in this compound may be utilized as a sole source of energy

Haintat Probably oil scaked soils. thundant in cutting compounds

19 Pseudomonus incognita Chester (Hacillus fluorescens incognitus Wright, Memours Nat. Cad. Sci. 7, 1905, 436, Chester, Determinative Bucteriology, 1908–323. From Latin, in, not, copilo, to think, M. L. unknown.

Short rods, with rounded ends, occurring singly, in pairs and in chains. Motile, possessing a polar flagellum. Gramnegative.

Gelvin colories Thin, transporent, slightly granulus, becoming greenish Margin undulate. The medium assumes a blue green fluorescence. 1937, 903-912; Dykstra, Phytopath., 29, 1939, 917-933.)

Marmor umbelliferarum H. (loc. cit., 67). From New Latin Umbelliferae, family name of plants among which celery is classified.

Common name: Celery-mosaic virus, western celery-mosaic virus.

Hosts: UMBELLIFERAE—Apium gracedens L., celery and celeriac; Daucus corola I., carrot. Experimentally, also Anchum gracedens L., dill; Antáriacus cer, folium (L.) Hoffm., salad chervil; Carum cares L., caraway; Coriandrum satteum L., coriander; Petroselinum hortense Hoffm, parsley.

Insusceptible species: Cucumis satirus L., eucumber, and all other tested species not of the family Umbelliferae.

Geographical distribution: United States (California).

Induced disease In celery, at first, clearing of veins in young leaves; later, foliage yellowed, pl.m stunted, young petioles shortened older petioles horizontal, giving plant a flat appearance. Foliage mottled green and yellow; leaflest marrow, twisted or cupped; older leaves with some necrosis; petioles with white streaks or spots. In celeriac, clearing of veins, followed by systemic chlorotic mottling. In carrot, chlorotic spotting of young leaves, followed by systemic chlorotic chlorotic mottling.

Transmission · By inoculation of expressed juice, in dilutions to 1:4000. No specific insect vector is known, but 11 species of aphids capable of breeding on celery transmit the virus, though they do not long retain the power of transmission after leaving diseased plants These vectors are Aphis apigrareolens Essig. A apii Theob , A. ferruginea-striata Essig, A. gossupri Glov , A. middletonss Thomas, A rumicis Linn, Caroriella capcircumflexus (Fabr.). Myzus (Buckt.), M. convolvuls (Kalt ), M. persicae (Sulz.), Rhopalosiphum melliferum (APHIDIDAE) (Hottes)

aphids not able to breed on celery also transmit this virus.

Thermal inactivation: At 55 to 60° C in 10 minutes.

Filterability: Passes all grades of Chamberland filters.

Other properties: Virus active after storage at -18° C for 18 months.

Literature: Severin and Freitag, Hilgardia, 11, 1938, 493-559.

 Marmor cruciferarum H. (loc cit., 69). From New Latin Cruciferae, family name of plants among which cauliflower is classified

Common name: Cauliflower-mossic virus.

Hosts: CRUCIFERAE-Brassica oleracea L., cauliflower, kale, Brussels sprouts, cabbage, and broccoli; B. campestris L., wild yellow mustard; Maithiola incana R. Br., annual stock. Erperimentally, also Brassica adpressa Boiss; B. alba Rabenh., white mustard, B. arrensis (L.) Ktze., charlock; B. juncea Coss., leaf mustard (one strain not susceptible); B. napus L., rape; B. petsai Bailey, pe-tsai; B. nigra Koch, black mustard; B. rapa L., turnip; Capsella bursa-pastoris Medic., shepherd's purse; Iberis amara L , rocket candytuft; Lepidium saticum L., garden cress, Lunaria annua L., honesty; Raphanus raphanistrum L., white charlock; R saturs L, radish.

Insusceptible species: CHENOPODIACEAE—Sprancia oleracea L. COUIPOSITAE—Lactuca sativa L. CRUGPERAE—Alyssum saratile L.; A.
maritimum Lam.; Arabis albida Stev;
Adhysamus pussilus Greene, Erastea
juncea Coss. (Japanese strain; another
strain susceptible); Chevranthus cherr
Li, Ergisumum perofskinum Fisch and
Mey.; Hesperis mattonatit L.; Matomia
maritima R. Br.; Roripa nastartum
tusby; Stantiga pimata (Pursh.) Britt;
Thyanocarpus radians Benth. LEGU.
MINUSAE—I veia faba L. SOLANA
CEAE—Capsicum frutescens L.; Lycoper-

British Queen). Immunity to sphid infection with this virus is found in the varieties Katahdin and Earlaine. A combination disease, characterised by pronounced yellow-mosaic patterns, is caused by this virus in the variety Irish Chrettain if the potato-veinbanding virus (Marmor upsilon) is also present. In tohacco, experimentally, faint veinbanding mosaic.

Transmission: To potato, by rubbing methods of inoculation of expressed juice, using carlorundum powder; to tobacco, by rubbing without carborundum. By aphilds, Aphis abbrevata Patch and Mysus pressoc (Suls: ) (APHIDIDAE)

Serological relationships: No crossprecipitin reactions with potato aucubamosaie vitus, potato-veinbanding vitus, tobacco-mosaie vitus, tobacco-etch virus, tobacco-ringujot virus, or pea mosaie

Immunological relationships. A feeble strain of this virus has been found to protect fully against the typical strain in the Netherlands

Thermal inactivation; At 50° C in 16 minutes.

Litenture Bavden, Ann. Appl. Biol., 25, 1925, 487-497; Chetter, Phytorth, 25, 1925, 68-5701. Dykstra, Phytopth, 29, 1937, 40-67; Hansen, Tideskr. Pinteaul, 44; 1937, 631-631; Murphy and Loughnane, Sci. Proc. Roy. Dublin Sec. 21, 1930, 419-419, Murphy and McKay, biol. 49, 1932, 237-247; Cortwijn Botges, Tujach Platennickten, 45, 1939, 25-23, Schulls et al., Phytopth, 27, 1937, 190 197; 59, 1910, 914-951.

II Marmor aucuba H (loe est, 49) from New Latin Ancuba, a genus of plants having mortifed foliage.

Common name. Potato auculia mesare

Hour SHAAAUEAE—Solanum tu terisum L. joitato Experimentilly, also Attoja Gilladiana I. (ayingtamlesi), Cayincum feuterena L., popper, Balura strasonium L., Jimon weed (wimptom less). Hyargamus migr. L., benlaine (symptomless); Lycopersicon esculentum Mill., tomato; Petunia hybrida Vilm., petuna (symptomless); Nicotiana tabacum L., tobacco (symptomless); Solanum dulcamara L., bittersweet; S. nigrum L., var. nodiforum.

Geographical distribution; United States, Great Britain, Europe.

Induced disease: In potato, yellow spots on lower leaves of some varieties; in the variety Irish Chieftain, brilliant yellow mottle over whole plant, perhaps because of simultaneous presence of potato mild-mosaic virus in this variety. Necrosis of the cortex and of the pith in tubers in many varieties.

Transmission: By inoculation of expressed juice Probably by aphid, Myzus persicae (Sulz.) (APHIDIDAE).

Serological relationships: No precipitin cross-reactions with potato mild-mosaie virus, polato-veinbanding virus, tobacco-mosaie virus, tobacco-etch virus, tobacco-misspot virus, or pea-mosaie virus, Precipitin cross-reactions with the Canada-streak strain of potato aucuba-mosaie virus.

Thermal inactivation. At 65 to 68° C in 10 minutes.

Filterability: Passes Pasteur-Chamberland L. filter, but not L. or L.

Laterature. Chester, Phytopath., 25, 1935, 686-701; 27, 1937, 903-912; Clinch, Sci. Proc. Roy. Dublin Soc., 22, 1941, 435-415, Clinch et al., ibid., 21, 1936, 431-448; Dykstra, Phytopath., 29, 1939, 917-933.

Strains: One strain differing from the type has been given a varietal name:

Ha Marmor aucuba var. canadense Black and Price (Phytopath, 50, 1940, 144) From common name of strain.

Common name Canada streak strain of potato aucula mesus virus. Differing from the type variety by tendency to produce necrosis in stems, sems, petioles, and feaves and also, about 2 months after Larvest, in pith of tuber, especially at stem end. (Clester, Phytopath, 27,

under identical circumstances. More work is needed to show existing alliances.

Literature: Chamberlain, New Zealand Jour. Agr., 63, 1930, 321-330; New Zealand Jour. Science and Technology, 21, 1939, 212A-223A; Clayton, Jour. Agr. Res., 40, 1930, 263-270; Gardner and Kendrick, ibid., 22, 1921, 1923-192; Hoggan and Johnson, Phytopath., 26, 1935, 610-614; Larson and Walker, Jour. Agr. Res., 59, 1933, 367-392; 62, 1941, 475-391; Schultz, Jour. Agr. Res., 28, 1921, 173-178; Smith, Ann. Appl. Biol., 22, 1935, 293-212; Tompkins, Jour. Agr. Res., 57, 1938, 559-602; 58, 1939, 63-77; Tompkins et al., ibid., 57, 1938, 593-943.

15. Marmor betae H. (loc. cit., 72). From Latin beta, bect.

Common name: Sugar-beet mosaic virus.

Hosts: CHENOPODIACEAE—Beta vulgaris L., beet; Spinacia oleracea L., spinach.

Geographical distribution: France, Denmark, Germany, Sweden, United States, England.

Induced disease: In beet, discrete yellowish secondary lesions or clearing of veins on young leaves, followed by chlorotic mottling of newly formed leaves. Darkening of vascular tissue. Leaves bend back near tips, which sometimes die. Intracellular bodies formed. In spinach, 6 to 21 days after infection, chlorotic flecks on young leaves. Plant stunted, outer leaves killed, dying from their tips back. Center of plant survives for a time, but finally dies.

Transmission. By inoculation of expressed juice, in dilutions to 10<sup>-1</sup>. By aphids, Myzus perstone (Sult ), Aphis rumicis Linn., and perhaps Macrostphum solanifolis Ashm. (= M. get Koch) (APHIDIDAE). No seed transmission.

Thermal inactivation: At 55 to 60° C in 10 minutes.

Other properties: Inactivated by standing in expressed juice for 24 to 48 hours at about 70° F.

Literature: Böning, Forsch. Geb. Pflanzenkr. u. Immun. Pflanzenteich, §, 1927 81-128; Cent. f. Bakt., II Abb., 71, 1927, 490-497; Gratia and Manii, Compt. rend Soc. Biol., Paris, 118, 1935, 379-381; Hoggan, Phytopath., 23, 1933, 446-441; Jones, Washington Agr. Exp Sta Bull. 259, 1931; Lind, Tidsskr. Planteavi, 22, 1915, 441-457; Robbins, Phytopath, 14, 1921, 349-363; Schmidt, Ber. Deutsch. Bott. Ges., 45, 1927, 598-600.

Marmor lactucae H. (loc. cit., 81).
 From Latin lactuca, lettuce.

Common name: Lettuce-mosaic virus.

Hosts: COMPOSITAE—Lactuce atica L., lettuce; Senecio cutgaris I.,
groundsel. Experimentally, also COMPOSITAE—Sonchus asper Hoffin,
prickly sow-thistle. LEGUMINOSAE
—Lathyrus odoratus L., sweet pea; Fisum
satitwan L., pea.

Insusceptible species: COMPOSITAE

—Sonchus oleraceus L, S. arrensis L,
Taraxacum officinale Web., Carduus arrensis Curt. CRUCIFERAE—Bras-

stramonium L.

Geographical distribution: United States, England, Germany, Bermuds.

Induced disease. In lettuce varieties, cleating of vein followed by systemic ehlorotic mottling, dwarfing and defective hearting, sometimes by scorching of leaf edges, wenn necrosis or necrotic flecking between veins.

Transmission: By inoculation of expressed juice, in dilutions to 1:100 if mixed with a little 0.5 per cent sodum sulphite solution and a trace of pondered carborundum. By aphids, Mycas persicae (Sulz.), and Macrosuphum ge. Koch (APHIDIDAE). Through seeds from diseased plants It is believed that seed borne virus is the most important source of primary inoculum in the spring.

Thermal inactivation: At 55 to 60° C

in 10 minutes.

sicon esculentum Mill.; L. pimpinellifolium Mill.; Nicotiana glutinosa L.; N. langsdorfii Weinni; N. takazum L. vars. Turkish and White Burley. TROPAE-OLACEAE—Tropacolum majus L. UMBELLIFERAE—Apium grarcolens I.

Geographical distribution. United States, England.

Induced disease: In cauliflower, clearing of veins, followed by mild chlorotte
mottling, veins usually banded with dark,
green, necrotic fleeks later in chlorotte
areas Midro curved, leaves distorted.
Plant stunked; terminal head or curd
dwarfed. Solanaceous plants appear to
be immune, a point of distinction between
thas virus and turnip-movaic virus, Marmor brastices.

Transmission: By inoculation of expressed juice, wing carborundum powder By many aphid species, Brercoryne brasicae (Linn), cabbage aphid; Rhopalosphum; pacudotrassicae Divis, false cabbige aphid, Myus persicae (Sult.), peach aphid; Aphig pracelens Essig, celery leif aphid; A. apigracelens Essig, celery aphid, A. middictonii Thomas, erigrom root aphid; A opigraceolens Essig, celery aphid, A. middictonii Thomas, erigrom root aphid; A opigrace (Fabr.), yellow sullow aphid, Myus circumfizus (Buckt.), hly aphid; Rhopalosiphum melliferum (Hotten), honeysuckle aphid (APHIDIDADA). No seed transmission

Thermal inactivation: At 75° C in 10 minutes.

Laterature Caldwell and Prentice, Ann. Appl. Biol., 23, 1912, 306-373, 374-379, Riswlins and Tompkins, Phytopath., 24, 1931, 1147 (Abst.); Tompkins, Jour-Age Res., 25, 1937, 33-46

14. Marmor brassicae H (II., loc cit., 70. Marmor matthiolie II., loc. cit., 71.) From New Latin, Brassica, generic rame of turnip

Common name. Turnip mesale virus Hosts. CRUCIFFRAE—Praissea rapa L., turnip, B. rapskrassica Mill., sweds or rutalsoga; B. napus L., rape; B.

nigra (L.) Koch, black mustard; B. oler. acea L. cabbare: Armoracia rusticana Gaertn., horse-radish; Cheiranthus cheiri L , wallflower; Matthiola incana R. Br., stock: Sinanes alba L., white mustard, Experimentally, also CRUCIFERAE-Revieroa incana (L.) DC : Brassica alba Rabenh., white mustard: B. greensis (L.) Kize .: B. chinensis L., Chinese cabhore: B. juncea (L.) Coss.: Capsella bursa-pastoris (L) Medic.; Cardamine heterophylla (Forst. f ) O. E. Schultz: Cherranthus allionis Hort : Coronopus didumus Smith: Hesperis matronalis L : Landrum ruderale L. : L. satirum L. L. ttrainicum L : Nasturtium officinale R. Br : Neslia paniculata (L.) Desv : Radicula palustris (L.) Moench : Raphanus satirus I ..: Sisymbrium allissimum L .: S officinale (L) Scop : Thiasps arrense CHENOPODIACEAE-Beta vulcaris L.: Spinacia oleracea L. spinach.

gori I.; Spinacia certare I.; spinacia; COMPOSITAE—Calendula officinalis I. Zinnia clegans Jacq RANUNCULA-CEAE—Delphinium apacet I. SOLANA-CEAE—Lycopersicon pimpinellyfolium Mill , Nicotiana byelorii 8 Watis, N glutinosa I., N langsdoffa Weinm , N repanda Willd , N. rustica I.; N. sylectits Spec, and Comes; N. tabacum I., tolneco, Petunia hybrida Vilm

Geographical distribution United States, England, New Zealand

Induced disease. In turnip, systemic chlorotic mottling; plants stunted, leaves distorted. In tobacco, experimentally, characteristic necrotic primary lessons only.

Transmission By inoculation of expressed juice. By cabbage aphid, Breescoryne brassicae (Linn.), and by the peach aphid, Mysus persicae (Sulz.) (APHIDIDAE)

Thermal inactivation: At 54° C in 10 minutes

Strains A considerable number of strains of this virus appear to occur in nature, but those that Lave been studied often have been considered as distinct viruses and not convored with each other

ally, also Cicer arietinum L.; Desmodium canadense (L.) DC.; Lathyrus sativus L., grass pen; Lupinus albus L., white lupine; L. angustifolius, blue lupine; L. densiflorus Benth.; L. hartweggi Lindl.; L. nanus Dougl.; Medicago arabica Huds., spotted bur clover; M. hispida Gaertn., oothed bur clover; Melilotus alba Desr., white sweet clover; M. indica All., annual yellow sweet clover; M. officinalis (L.) Lam., yellow sweet clover; Phascolus acutifolius Gray, tepary bean; P. vulgaris L., bean; Trifolium agrarium L.; T. carolinianum Michx.; T. dubium Sibth.: T. glomeratum L , cluster clover: T. hubridum L., alsike clover; T. incarnatum L., crimson clover; T. procumbens L.; T. reflexum L .: T. suaveolens. Persian clover: Vicia sativa L., common vetch.

Insusceptible species: All tested species in families other than the Leguminasac.

Geographical distribution: United States, British Isles, Europe, New Zealand.

Induced disease: In pea, clearing of veins in young leaves, followed by chlorosis of newly formed leaves, stunting of plant, and systemic chlorotic mottling. In sweet pea, systemic chlorosis and chlorotic mottling, flower colors broken In lupine, neerotic streak on one side of stem, stunting of plant and bending of growing point to injured side. Plant soon wilts and dies. In Vicia Joha, motted leaves contain characteristic isometric crystals in host-cell nuclei (especially within nucleoli) as well as in cell evtoplasm

Transmission By inoculation of expressed juice, with ease. By aphids, Macrossphum pits Kalt., M. solanifolii Ashm (= M. ge: Koch), and Aphis rumicis Linn (APHIDIDAE). Not transmitted through seed.

Serological relationships: Specific precipitin reactions differentiate this virus from tobacco-mosaic virus, tobacco-etch virus, potato-mottle virus, potato mildmosaic virus, potato aucuba-mosaic virus, and tobacco-ringspot virus Thermal inactivation: At 60° C in 10 minutes.

Literature: Chester, Phytopath, 25, 1935, 685-701; Doolitle and Jones, 15sd, 15, 1925, 763-772; Johnson and Jones, 15sd, Agr. Res., 64, 1937, 623-633; McWhorter, Phytopath., 51, 1941, 769-761; Marphy and Pierce, 15dd., 27, 1937, 150-761; Marphy and Pierce, 15dd., 27, 1937, 180-603; Pierce, Jour. Agr. Res., 61, 1935, 1017-1039; Spierenburg, Tijdschr. Plantenz, 47, 1938, 191-76; Zaumeyer and Wade, Jour Agr. Res., 65, 1936, 161-195.

Marmor pisi H. (loc. cit, 90).
 From Latin pisum, pea.

Common name: Pea enation-mosaic virus.

Hosts: LEGUMINOSAE-Pisum sativum L., pea; Vicia faba L. broad bean Experimentally, also Lathyrus odoratus L., sweet pea; Soja max (L.) Pipet, soy bean; Trifolium incarnatum L., crimson clover.

Insusceptible species: LEGUMINOSAE-Artachis hypogaea L., peanut,
Medicago saita L., alfalfa; Melilolus alba
Desr., white sweet clover; M. oficinalis
(L.) Lam., yellow sweet clover; Phaseolus aureus Roob, mung beans P. vulgaris
L., bean; Trifolium hybridum L., alsike
clover; T. pratense L., red clover; T.
repens L., white Dutch clover. SOiANACEAE—Lycopersicon exculentum
Mill., tomato; Solanum tuberosum L.
rotato.

Geographical distribution: United States, perhaps Germany.

Induced disease: In peas, systemic chlorotic mottling; in some varieties, as Alderman, occasional necrotic spots and numerous enations on lover surfaces of leaves. Pods distorted. In broad bean, systemic chlorotic spotting and striping of leaves. In sweet pea and soy bean, experimentally, systemic chlorotic mottling.

Transmission: By inoculation of expressed junce, using carborundum; more readily from aphid-inoculated plants than from mechanically-inoculated plants Filterability: Fails to pass L. Pasteur-Chamberland filter.

Literature: Ainsworth and Ogilvie, Ann Appl Biol., 26, 1939, 279-297; Jagger, Jour. Agr. Res., 20, 1921, 737-740; Newhall, Phytopath., 13, 1923, 104-106.

 Marmor dahliae H. (loc cit, 85).
 From New Latin Dahlia, generic name of host plant.

Common name: Dablia-mosaic virus.

Hosts: COMPOSITAE—Dablia pinnata Cav , dablia. Experimentally, also

D imperialis Rocal.; D. mazonis Safford. Geographical distribution: United States, Holland, Germany, England

Induced disease: In intolerant varieties of dahla, chlorotic mottling of foliage, leaf distortion, dwarfing of all stems and of roots, occasionally necrotic streaking of mulcient. In tolerant varieties, inconspicuous chlorotic mottling or masked symntoms.

Transmission. By aphid, Myzus persicae (Sulz.) (APHIDIDAE). By grafting Not by inoculation of expressed junce Not through soil. Not through seeds from diseased plants.

Laterature Briefley, Am. Dahlia Soc. Bull , Ser 9, No 65, 1933; Contrib Boyce Thompson Inst. 5, 1933, 235-288; Goldstein, Bull Torrey Bot. Club, 54, 1927, 285-273

15 Marmor phaseoli H (loc. cit, 87) From New Latin Phaseolus, generic name of bean

Common ranne. Bean mesate virus. Heats. LLGUMINOSAR—Phaseolius religirus L. Jean. Experimentally, also Phaseolius acutifolius Gray ver datifolius. Preem. P. auerus Roch. P. calcaratus. Roch. P. binatus L., Lespeden strade (Thumb Hook, and Ann., Viena faba L., F. sapra I., spring vieta.

Insurceptible species LFGUMINO-SAF-Pisum satisum L, garden pea, Lathyrus of ratus L, sweet pes

Geographical distribution. World unde, at operat learn are grown. In tured disease: In Isan, first leaves to be affected are crinkled, stiff, chlorotic; later leaves show chlorotic mottling; leaf margins often rolled down. Optimum temperature for expression of disease, 20 to 25° C, partial masking at 28 to 22° C, complete masking at 12 to 18° C.

Transmission: By inoculation of expressed juice in dilutions to 1:1003, using carborundum or other abrasive powder. By aphids, Aphis rumicis Linn., Macrosiphum (= Illinoia) solanifolii Ashm., M. pisi Kalt., Aphis gossypii Glov., A. medicaginis Koch, A. spiraccola, Brevicoryne brassicae (Linn.), Hyalopterus atriplicis Linn., Macrosiphum ambrosiae Thos. Rhopalosiphum pseudobrassicae Davis, and Myzus persicae (Sulz.) (APHIDIDAE). In beans, there is seed transmission to 30 to 50 per cept of plants grown from infected parents; pollen from infected plants is said to transmit virus.

Thermal inactivation. At 56 to 58° C in 10 minutes.

Laterature . l'ajardo, Phytopath., 20, 1930, 409-491, 883-888; Murphy, abid., 30, 1910, 779-781; Murphy and Pierce, ibid . 28, 1938, 270-273; Parker, Jour. Agr. Res., 52, 1936, 895-915; Pierce, Phytopath., 24, 1931, 87-115, Jour. Agr. Res., 49, 1931, 183-188; 51, 1935, 1017-1039; Reddick, H Congr. Intern. Path Comp., 1931, 363-366; Reddick and Stewart, Phytopath , 8, 1918, 530-531; Richards and Burkholder, Phytopath., 53, 1913, 1215-1216; Wade and Andrus, Jour Agr. Res . 63, 1911, 359-373; Wade and Zaumeyer, U S Dept Agr , Circ 500, 1938; Walker and Johnstte, Phytomath., 53. 1913, 778-788, Zaumeyer and Kearns, ibid , 26, 1936, 614-637, Zaumeyer and Wade, Jour Age Res , \$1, 1935, 715-749.

19 Marmor leguminosarum H. (loc. est., vi) From New Latin Leguminosae, family name of pea Common name; Pea mosaic virus.

Hosts. LEGUNINOS, E-Lathyrus oforatus I., sweet pen; Pinen estirum I., pen; Trifolium pratense L., redelores; Vicia fala L., broad bran. Experiments 446). From New Latin Solanum, generic name of potato.

Common name. Potato-calico strain of alfammon virus. Differing from the type by inducing a more severe disease in potato, in which it is commonly found in nature. (Price and Black, Phytopath., 30, 1910, 444-447; Dykstra, ibid., 29, 1939, 917-933; Porter, Potato Assoc. Amer. Proc., 18, 1931, 65-69; Hilgardia, 6, 1931, 277-294; 9, 1935, 383-394.)

 Marmor tulipae H. (loc. cit., 52).
 From New Latin Tulipa, generic name of tulip.

Common name: Tulip color-adding virus.

Hosts: LILIACEAE-Tulipa gezneriana I., garden tulip; T. eichleri Regel; T. greigi Regel.

Insusceptible species: AMARYLLI-DACEAE—Narcasus sp., narcissus IRIDACEAE—Iris germanica L., iris. LILIACEAE—Allium cepa L., onion. SOLANACEAE—Nicotiana tabacum L., tobacco.

Geographical distribution: Wherever hybrid tulips are grown.

Induced disease. In tulip, no obvious effect on leaves but dark striping of flower by pigment intensification. Little interference with growth of plant. No intra-cellular bodies.

Transmission: By hypodermic injections of expressed juice in dilutions to 10<sup>-8</sup>. By sphids, Myzus persicae (Sulz ), Macrosiphum solanifoli Ashm. (= M. gei Koch, Illinoia solanifoli Ashm Aphis (= Anuraphis) tulipae B. de Fonse. (on bulbs), and perhaps Macrosiphum pelargonii Kalt. (APHIDIDAE) Not through seeds from diseased plants.

Not through seeds from diseased plants. Thermal mactivation At 65 to 70° C in 10 minutes.

Literature: Hughes, Ann. Appl. Biol., 18, 1931, 16-29; 21, 1934, 112-119, Mc-Whorter, Phytopath., 22, 1932, 998 (Abst.); 25, 1935, 898 (Abst.); Ann. Appl. Biol., 25, 1938, 254-270.

23. Marmor mite H. (loc. cit., 53). From Latin mitis, mild.

Common name: Lily latent-mosaic virus.

Hosts: LIUIACB AE—Latium amable;
L. auratum Lindl.; L. canadense L.; L.
canadidum L; L. cernaum; L. chalcdonicum L.; L. croceum Chaix; L. damottae;
L. elegans Thunb.; L. formosanun
Stapf.; L. giganteum; L. henryi Baker; L.
leucanthum; L. longiforum Thunb.; L.
myriophyllum; L. pumitum; L. repete
Wils.; L. sargentiae Wils.; L. speciosum
Thunb.; L. superbum L.; L. testaceum
Lindl.; L. tigrinum Ker; L. umbildum
Hort.; L. wallacei; Tulipa gesneriana L,
garden tulip; T. clusiana Vent.; T. limtalin Recel.

Insusceptible species: LILIACEAE— Allium cepa L., onion; Lilium kanson Leichtl. IRIDACEAE—Iris germanica L., iris. SOLANACEAE—Nicolana labacum L., tobacco.

Geographical distribution Wherever lilies and tulips are cultivated.

Induced disease: In Easter lily, masked symptoms or systemic chlorotte motiling, in either case without necrotic flecking. In tulip, systemic chlorotte motiling in foliage and flower "breaking" (color moval, except in a few varieties in which color intensification occurs instead). Intracellular bodies characterize invaded tissues.

Transmission. By inoculation of expressed juice (rubbing surface of leaves), in both filly and tulip. By plugging and grafting of dormant bulbs of tulip. By aphuds, Mysus persence (Sulz.), Macrosphum solamfolin Ashm. (= M. git Koch), and Aphis (= Auraphin) tulipet B. de Fonse. (APHIDIDAE). Not through seeds from mosaic Latium longituderum.

Thermal inactivation: At 65 to 70° C in 10 minutes.

Literature: Atanasoff, Bull. Soc. Bot. Bulgarie, 2, 1923, 51-60; Brierley, Phytopath., 29, 1939, 3 (Abst.); 50, 1940, 230Infective in dilutions to 10-4. Byaphids, Macrosiphum pisi Kalt. and M. solanifolii Ashm. (= M. ges Koch) (APIII-DIDAL), with incubation periods of about 12 hours before the insects can infect Not through seeds from diseased plants

Thermal inactivation: At 66° C in 10 minutes

Literature · Böning, Forsch, Geb. Pflanzenkr u Immun Pflanzenreich, 4, 1927. 43-111, Johnson and Jones, Jour. Agr Res. 54, 1937, 629-638; Loring et al., Proc Soc Exp. Biol and Med; 38, 1938, 239-241; Osborn, Phytopath , 25, 1935, 160-177, 28, 1938, 749-751, 923-931, Pierce, Jour Agr Res., 51, 1935, 1017-1039, Snyder, Phytopath., 24, 1931, 78-80; Stubbet, 1614., 27, 1937, 212-266

## 21 Marmor medicaginis II (loc cit. I'mm New Latin Medicago, generic name of alfalfa (lucerne).

Common name Alfalfa-mo-aic virus Hosts LEGUMINOSAE-Medicago satua L., alfalfa (lucerne) SOLANA-CEAE- Solanum tuberosum L. potato Experimentally, also transmissible to many species of dicotyledonous plants (summarized by Price, Am Jour Bot . 27, 1910, 530 511) including CUCURBI-TACEAE - Cucumit roticus L., eucum-COMPOSITAE-Zinnia elegana bet Jacq. 21ftfff13 LEGUMINOSAE-Phascolus tulgaris L., bean, Trifolium ercarnatum L., etimmon closer SOL ANACTAE-Capucum feulescens L. pepper. Lycoperation esculentum Mill . tomato, Nicoliana labacum L. toliacco Geographical distribution United

histor

Induced disease. In alfalfa, systemic chi rotte mottling, tending to be marked at titues. In lean, (meet sameties) small necrotic primary leaving, reddish brown at periptery. No secondary leerica frome bean sanctics slow no become after inegulation, one of these, Refugee Rogue, processes two dominant correspit ere f which will confer this type at regulation. In toluron, white premitic

flecks, small rings and arcs on inoculated leaves, later, systemic mottling, followed by production of necrotic oak-leaf patterns: virus content may be low in plants long diseased, especially in summer

Transmission: By inoculation of expressed juice By aphids, Vacrosiphum pist Kalt. (for typical strain) and M. zolanifolii Ashm. ffor potato-calico strain) (APHIDIDAE) Not through seeds from diseased plants.

Immunological relationships: Resistance to superinfection with the type of this virus is conferred by earlier infection with notato-calico virus (now considered a related strain but earlier regarded as distinct), but not by earlier infection with potato-mottle virus, cucumbermosaie virus, or the Canada streak strain of potato aucuba-mosaic virus.

Thermal inactivation - At 65 to 70° C in 10 minutes

Other properties Sedimentation constant, 739 ± 52 × 10-11 cm per sec. in a unit centrifugal field Specific volume 0 673 Particles spherical or nearly so Diameter 165 millimicrons, weight 21 × 10 times hydrogen unit Isoelectric point about pH 46. Inactivated and, more slowly, hydrolyzed by trypsin

Literature: Black and Price, Phytomth . 59, 1910, 411-417, Lauffer and Hove, Jour Am Chem Soc , 62, 1910, 3296-3300, Pierce, Phytopath , \$4, 1931, 87-115; Price, Am Jour Bot , 27, 1940, 530-541; Ross, Phytopath , 51, 1911, 391-410, 410-120, Wade and Zaumeyer, Jour. Am. Soc. Agron , 52, 1910, 127-131, Zaumeser. Jour Agr Res , 59, 1938, 747-772.

Strains At least one strun of alfalfame-air virus was formerly considered as an independent virus, causing a discase known as called in justate. It has now teen given varietal rank and detinguided from the type, war typicum Black and Price (Phytopath , 29, 1910, 416) by the following tame,

21s Marmor medicag nie var golgne Black and Price (Phytogath , 29, 1919, Other properties: Active after storage 27 days at -6° C.

Literature: Brandes, Jour. Agr. Res., 19, 1920, 131–138, 517–522, 24, 1923, 247–262; Desai, Current Science, 5, 1935, 18; Forbes and Mills, Phytopath., 33, 1943, 713–718; Ingram and Summers, Jour. Agr. Res., 62, 1936, 579–888; Kunkel, Bull. Exp. Sta. Hawniian Sugar Planters' Assoc., Bot. Ser., 5, 1921, 115–167; Matz, Jour. Agr. Res., 46, 1933, 821–839; Rady, Indian Jour. Agr. Science 5, 1935, 663–670, Scin, Jour. Dept. Agr. Porto Rico, 14, 1930, 49–68; Stoneberg, U. S. Dept. Agr., Tech. Bull. 10, 1927; Tate and Vandenberg, Jour. Agr. Res., 59, 1939, 73–79.

Marmor cepae H. (loc. cit., 66).
 From Latin cepa, onion.

Common name: Onion yellow-dwarf virus.

Host. LILIACEAE—Allium cepa L., onlon (the variety enriparum Metz. is symptomless when infected and may serve as an unrecognized reservoir of virus).

Geographical distribution: United States, Germany, Czecho-Slovakia, Russia, New Zealand.

Induced disease In onion (most varieties), yellow streaks at base of developing leaf, followed by yellowing, crinking, and flattening of newly formed leaves; leaves prostrate, flower stalks bent, twisted, stunied; plants reduced in size, bulbs small, yield of seeds reduced. A few varieties of onion are relatively tolerant, and the tree-onion, var. viviparum is symptomless after infection.

Transmission: By inoculation of expressed juice. By 48 of 51 tested species of aphid, principally Aphis runners Lann., A. mandes Fitch, and Rhopalosyphum Not.

by contaminated soil.

Thermal inactivation. At 75 to 80° C

Other properties: Virus withstands dilution to 10-4, storage at 29° C for about 100 hours and storage at  $-14^{\circ}$  C for more than time tested (6 hours), but is inactivated by drying in leaf tissues.

Literature: Andreyeff, Rev. Appl. Mycol., 17, 1938, 575-576; Blattny, Ochrana Rostlin, 10, 1930, 130-138; Bremer. Phytopath. Ztschr., 10, 1937, 79-105; Brierley and Smith, Phytopath., 34, 1944, 506-507; Chamberlain and Baylis, New Zealand Jour. Science and Technology, 21, 1939, 229A-236A; Drake et al , Iowa State Coll. Jour. Science, 6, 1932, 317-355; Jour. Econ. Ent., 26, 1933, 841-816; Henderson, Phytopath., 20, 1930, 115 (Abst.); Iowa State Coll. Research Bull. 188, 1935, 211-255; Melhus et al., Phytopath., 19, 1929, 73-77; Porter, U. S. Dept. Agr., Plant Dis. Rept., 12, 1928. 93; Tate, Iowa State Coll. Jour. Science, 14, 1940, 267-294.

27. Marmor scillearum Smith and Brierley (Phytopath., 34, 1944, 503.) From New Latin Scilleae, name of tribe in which hosts are classed.

Common name: Ornithogalum-mosaic

Hosts: LILIACEAE (of the tribe Scilleae)—Ornithogalum thyrsoides Jacq.; probably also Galtonia candicans Decne.; Hyacinthus orientalis L., hyacinth; Lachenalia sp.

Insusceptible species: LILIACEAE (of the tribe Scillege)—Muscari botry-

DACEAE—Paneralium maritimum; Zephyranthus sp. IRIDACEAD—Tritonia crocata (L.) Ker. LILIACEA—
Agoganthus africanus; Allium esp.
onion; A. cernuum Roth.; A. fistaloum
L.; A. porum I.; Glorious orthechidiana
O'Brien; Lilium formosanum Stapt; and
L. longiforum. SOLANACEAE—Nicetitana tabacum I.

Geographical distribution: United States (Oregon; probably also Alabams and presumed to be widespread in plants of the squill tribe, Scilleae, of the Ismily

LILIACEAE).

Not.

237; 5f, 1911, 533-813; Brierley and Doluttle, töid., 50, 1910, 171-174; Cayley, Ann. Appl Biol., 16, 1928, 522-533; 19, 1932, 153-172; Guterman, Hort. Soc. N. Y., Vearlb., 1320, 51-102; Hull, Gard Chron., 62, 1933, 333-331; Hughes, Ann Appl. Bod., 2f, 1931, 112-119; McKay and Warner, Nat. Hort. Mag., 12, 1933, 179-216; McWhorter, Phytopath, 2f, 1933, 593 (Abst.); Science, 68, 1937, 179; Ann. Appl Biol., 25, 1938, 251-270, Science, 83, 1938, 411; Oglivic and Guterman, Phytopath, 19, 1929, 311-315.

21 Marmor tridis II. (loc. est , 55) From New Latin Iris, generic name of tris

Common name: Iris-mosaic virus

Hosts: IRIDACEAE—Iris filifolia Rosss, I. tingitana Rosss, and Reut, and I xiphium L., bullousinses; Iris ricardi Hort, I unguicularis Poir.; bearded iris, variety William Mohr

Insusceptible species: SOLANA-CEAE—Lycopersion esculentum Mill., tomato; Nicotiana tabacum L., tohacco, Petunia hybrida Vilm, petunia LILIA-CEAE—Tulipa gesneriana L., tulip

Geographical distribution United States (Washington, Oregon, California), Holl and, Bulgarra, France, England Induced disease. In Bulbous 1118es.

dwarling of plant, chloretic motting of foliuge, breaking of flowers. Rate of increase in planting stock decreased Hower breaks usually durker than normal color of flower. Vacuolate intracellular ladies in some affected lissues.

Transmission: By injection of freshly extracted juice of diseased plants into intermedal tissue. By aphids, Macrosphure (\*\* Illinoid) solanifolis Volumend Mysix persione (Sulx.) (APHIDI DAE).

Latersture Briefley and McWhorter, Jour Age Res , \$5, 1976, 621-635

23 Marmor sacchart II (be eit , 60) I'nin New Latin Succerum, generic name of sugar cane, front Latin sac-

Common name: Sugar-cane mosaic

Hosts: GRAMINEAE—Saccharum officinarum L., sugar cane; Haleus sorghum L., sorghum; H. sudanensis Balley, Sudan grass; Brachiarua platyphylla Nash, Chactochloa magna Seribun, C. erticillata Seribn, Paspalum boscianum Fluegge: Syntherisma anaquinale Dulac. Experimentally, also Zea mays L., corn (maite); Chactochloa lutescens Stuntz; Echmochloa crusgalit Beauv.; Mascanthus sinnisis Andersa, cubilis; Panicum dichotomylforum Michx. Pennistum glaucam R. Rr., pearl millet; Saccharum narenae Wall.

Insusceptible species: All tested species other than Grammege, Geographical distribution. Originally

in I'ar Last, now in nearly all countries where sugar cane is grown; believed still to be absent from Mauritius.

Induced disease: In augar cane, aysteme mottling chlorosis, light areas of pattern chongried, but crossing vens Occasionally, stem cankers Regularly, discoloration and necrosis in nature inner stalk tissues Vanculate intracellular fedices occur in diseased tissues Canes sometimes recover, spontaneously foung the virus and becoming succeptible to reinfection. Transmission By inoculation of extractions and the contraction of extractions are supported to the contraction.

pressed pince (puncture through inoculum into young leaf). By aphids, Aphie models (K. Grobinous expert Ainshey, Hytteoneura sitariae (Thomses), and Tacoptera grasinium Road; not by Sipha fara Torless (APHIDIDAE). Not by Bracedaerphila melliper (Sty) (CICABELLID IE)

Semispical relationships Specific neutralizing and precipitating antibodies have been demonstrated

Thermal mactivation At 53 to 51°C in 10 minutes in leaf tissues Gelatin stab: No liquefaction.

Agar slant: Thin, moist, translucent, becoming greenish.

Broth: Turbid, with pellicle, becoming greenish.

Litmus milk: Slightly acid in a month. The litmus is slowly reduced. Potato: Moist, glistening, spreading,

brown. Indole is formed (trace).

Nitrites are produced from nitrates.

Aerobic, facultative. Optimum temperature 35°C.

Habitat: Water.

20. Pseudomonas convexa Chester. (Bacillus fluorescens convexus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 438; Chester, Determinative Bacteriology, 1901, 325.) From Latin, convexus, convex, arched.

Short, thick rods, with rounded ends. Motile, possessing a polar flagellum. Gram-negative

Gelatin colonies. Circular, convex, glistening, bright greenish, translucent. The medium becomes blue-green, fluorescent.

Gelatin stab. Light green, raised. glistening surface growth. No liquefac:

Agar slant: Moist, translucent, glistening, light greenish. The medium 4ssumes a greenish color

Broth: Turbid, becoming greenish Litmus milk: No coagulation; alkalne.

Potato: Pale brown, spreading.

Indole not formed.

Nitrates not produced from nitrates Aerobic, facultative.

Optimum temperature 30°C. Habitat · Water.

21. Pseudomonas mildenbergii Be gey et al. . Der blaue bacillus, Milder

berg, Cent. mg Bakt, II Abt., 58, 192 309; Pseudo y pan tyanogena Bergey al , Manual, 1 , et , 1973, 129; not Bacil Flegge, Die Mikroorganismen, 1886, 201; not Pseudomonas cyanogenes Hammer, Dairy Bact., 1928, 70; Bergey et al., Manual, 3rd ed., 1930. 172) Named for Mildenberg who first isolated this species.

Rods: 0.3 to 0.5 by 1.0 to 3.5 microns. with rounded ends, occurring singly, Motile, possessing polar flagella. Gram-

negative. 'colonies: Circular, lobed. Gelatin smooth, glistening, slightly raised, steelblue, entire.

Gelatin stab: No liquefaction.

Aga 3 colonies: Small, circular, yellowish or reddish-yellow, entire, becoming lobe i, grayish-green, iridescent. The medium becomes dirty gravish-green.

Apar slant: Smooth, spreading, slimy, gl'stening, grayish-green to dark green.

fl lorescent.

Broth: Turbid green, iridescent to nnalescent with slimy sediment.

Litmus milk: Not congulated, blue ring.

Potato: Slimy, glistening, spreading, steel blue.

Indole not formed. Nitrites not produced from nitrates.

Aerobic, facultative. Optimum temperature 25°C.

Source: Isolated from air.

Pseudomonas putida (Trevisan) Migula. (Bacillus fluorescens putidus Flügge, Die Mikroorganismen, 2 Aufl, 1886, 288; Bacillus putidus Trevisan, I gen. e le specie d. Batteriacee, 1889, 18; Migula, in Engler and Prantl, Die natur. Pflanzenfam., 1, 1a, 1895, 29: Bacillus fluorescens putridus (sic) Kruse. in' Flugge, Die Mikroorganismen, 2. 1896, 292; Bacterium putidum Lehmarn and Neumann, Bakt. Diag., 1 Aufl., 2. 1896, 271; Pseudomonas putrida (sic) Migula, Syst. d. Bakt., 2, 1900, 912.) It is not clear which spelling should be used. Either is correct. From Latin putida or putrida, rotten, stinking. Rods, with rounded ends. Motile,

Induced disease: In Ornithogalum thyrsouder, young leaves finely mottled with light and dark green, and becoming more conspicuously mottled with gray or yellow as the leaves mature; flower stalks sometimes boldly marked with light and dark green blotches In perianth segments, thin longitudinal streaks Transmission: By inoculation of expressed juice in the presence of fine carborundum powder, with Adificulty. By aphids, Aphis possuprii Glov., Macrosiphum Ititi Monell, M. solanijolii Ahm. and Myzus persicae (Sulz.); less efficiently by Myzus circum/fexus (Buckt.) (APHIDIDAE).

## Key to the species of the Miscellaneous Mosaic-Virus Group.

Many of the following viruses, although described in some detail in the literature, stand in need of reinvestigation to determine additional properties and possible relationships to preceding groups.

- I. Affecting species of MALVACEAE,
- 28. Marmor abutilon.
  II. Affecting species of CELASTRACEAE
- 29. Marmor euonymi.
- III Affecting species of OLEACEAE
  30 Marmor liquitri.
- IV. Affecting species of LEGUMINOSAE (and no. 39, other families also).
  - 31. Marmor laburni.
  - 32. Marmor arachidis.
  - 33 Marmor trifolii.
  - 34. Marmor pachyrhizi. 35. Marmor vianae
  - 35. Marmor vignae 36. Marmor repens.
  - 37. Marmor fastidiens.
  - 38. Marmor iners
  - 39. Marmor efficiens.
  - V Affecting species of GRAMINEAE
  - 41. Marmor graminis.
- VI. Affecting species of MUSACEAE.

  42 Marmor abaca
- VII Affecting species of PASSIFLORACEAE

  43 Marmor passiflorae.
- VIII. Affecting species of ROSACEAE.
  - 44. Marmor flaccumfaciens.
    - 45. Marmor rosae.
    - 46. Marmor veneniferum.
    - 47. Marmor mali.
    - 48. Marmor fragariae
    - 49. Marmor marginans.
    - 50. Marmor rubi.
    - 51. Marmor persicae.
    - 52. Marmor astri.
    - 53. Marmor rubigingsum.
    - 51. Marmor cerasi. 55. Marmor lineopictum.
    - 56. Marmor pallidolimbatus.
    - 57. Marmor nerviclarens.

- IX. Affecting species of VITACEAE.
  - 58. Marmor viticola.
  - X. Affecting species of SANTALACEAE.
- XI. Affecting species of CONVOLVULACEAE and, experimentally, of other
- 60. Marmor secretum
- XII. Affecting species of GERANIACEAE.
- 61. Marmor pelargonii.

  XIII. Affecting species of SOLANACEAE and in most cases also of other families,
  - 62. Marmor angliae.
    - 63. Marmor aevi.
- 64. Marmor raphani. XIV. Affecting species of PRIMULACEAE.
  - 65. Marmor primulae.
- XV. Affecting species of MORACEAE.

  66. Marmor caricae.
- XVI. Affecting species of RUTACEAE.
  - 67. Marmor italicum.

Marmor abutilon H. (loc. cit., 50).
 From New Latin Abutilon, generic name of a host.

Common name : Abutilon-mosaic virus Hosts: MALVACEAE-Abutilon striatum Dicks. var. thompsonii Veitch. Experimentally, also Abutilon arboreum Sweet; A. avicennae Gaertn.; A. esculentum St. Hil,; A. indicum Sweet; A. ineigne Planch.; A. megapotamicum St. Hil. and Naud , A. regnellu Miq ; A. sellowianum Regel, A. venosum Lem ; A. vitifolium Presi.; Althaea ficifolia Cav.; A. officinalis L ; A. rosea Cav.; Anoda hastata Cav ; Kıtaıbelia vitifolia Willd ; Malva borealis; M crispa; M, mauritiana Mill.; M. sylvestris L ; M. verticillata L ; Malvastrum capense Garcke: Modiola decumbens G. Don ; Sida mollis Herb ; S. napaea Cav.; Sidalcea candida A. Gray.

Insusceptible species: MALVACEAE
—Althaea taurinensis; Sidalcea purpurea;
Sphaeralcea umbellata G. Don.

Geographical distribution: Germany, France, England, United States; onginally obtained from a single variegated seedling found among green plants of Abution stratum imported from the West Indies in 1868 by Veitch and Sons; subsequently the infected plant \*\*1321

propagated vegetatively as an ornamental variety.

Induced disease: In Abution, systemic chlorotic mottling. Recovery occurs if there is persistent removal of affected leaves, suggesting that the virus does not increase in stems. After recovery, plants are susceptible to reinfection.

Transmission: By grafting, except patch-bark-grafting, which is ineffective Occasionally through seeds from diseased plants. Not by inoculation of expressed unce. No insect vector is known

Varieties: Distinctive strains have been noted, but not separately namely one isolate originally occurring in Abuliland arrain var. teasclatum, seems to belong here; it differs from the type principally in severity of induced disease and in ability to infect Laustra arbora

Literature: Baur, Ber. d. Deutsch Bel.
Gesellsch , £2, 1904, 453-460; £4, 1906,
416-428; £5, 1907, 410-413; K. PreusAkad. Wiss., Sitzungsber., 1906, 11-19;
Davis, Ann. Missouri Bot. Gard., ½,
1929, 145-226; Hertzsch, Ztechr. J. Dob.,
20, 1927, 63-85; Keur, Phytopath. £4,
1933, 20 (Abst.); £4, 1934, 12-13 (Abst.);
Bull. Torrey Bot. Club, £1, 133, 53-70;
Landemath, Garlenflora, £1, 1902, 237-

29. Marmor evonymi H (loc. cit, 51). From New Latin Evonymus, generic name of bost.

Common name: Euonymus-mosaic

Virus
Hosts · CELASTRACEAE—Euonymus japonica L f (sometimes written
Etonymus japonicus) Probably also E

radicans Sieb. Geographical distribution: Germany.

Induced disease. In Euonymus japonica, persistent vellowing along veins

Transmission . By grafting.

Literature Baur, Ber. d. Deutsch Bot. Gesellsch, 26a, 1908, 711-713, Rischkon, Biol Zentralbl, 47, 1927, 752-764

30 Marmor ligustri H (loc. cit, 52) From New Latin Ligustrum, generic name of bost, from Latin ligustrum, ancient name of privet plant.

Common name. Ligustrum-mosaic

VITUS Host OLCACEAE-Ligastrum vul-

gare L., common privet
Geographical distribution. Germany
Induced disease Systemic chlorotic

spotting
Transmission By grafting Not

through seeds from diseased plants.
Literature. Baur, Ber. d. Deutsch
Bot Gesellsch, 25, 1907, 410-413

31 Marmor laburni H. (loc. cil., 51). From generic name of a host plant, Laburnum vulgare

Common name Laburnum-mosaic

Hosts LEGUMINOSAE—Laburnum vulgare Griseb. (= L anagyroides Medic), bean tree. Experimentally, also Cutsus hirsulus L.

Insusceptible species. LEGUMINO-SAE-Laburnum alpinum Griseb., Cytisus purpureus.

Geographical distribution Germany Induced disease. Systemic chlorotic variegation.

Transmission: By bark grafts or by

budding. Not through seeds from dis-

Literature: Baur, Ber. d Deutsch. Bot. Gesellsch., 25, 1907, 410-413

32 Marmor arachidis H. (loc cit., 67) From New Latin Arachis, generic name of peanut

Common name. Peanut-rosette virus Host . LEGUMINOSAE-Arachis hu-

pogaea L., peanut

Geographical distribution. Union of South Africa, Madagascar, Tanganyika Territory, Uganda, Senegal, Gambia, Sierra Leone, Java.

Induced disease In peanut, yellowing of young leaves, at first with green veins;

leaflets Seed formation immoned A abnormal proliferation of tissues.

Transmission: By grafting By both winged and wingless individuals of the aphild, Aphils laburnt Kalt (= A legum-nocae Theob ) (APHIDIDAE). Not by 13 tested species of leaftnoppers. Not by inoculation of expressed juice. Not through seed from diseased plants. Not through seed from diseased plants.

Literature Hayes, Trop Agr., 9, 1932, 211-217; McClintock, Science, 45, 1917, 47-48, Soyer, Publ. Inst. Nat. Etud. Agron. Congo Belge, Sér. Sci., 21, 1939, 23 pages (Rev. Appl. Mycol., 19, 1940,

59-63.

33. Marmor trifolii H (loc. cit , 93)

saic virus.

Hosts: LEGUMINOSAE—Trifolium pratense L., red clover, Lathyrus odoratus L., sweet pea; Vicia faba L., broad bean. Experimentally, also Trifolium hybridum L., alsike clover, T. incarnatum L., crimson clover; T. repens L., white clover; Melilotus alba Desr., white sweet clover; Pisum sativum L., pea.

Insusceptible species: LEGUMINO-SAE—Phascolus rulgaris I., bean; P. aureus Roxb., mung beam; Medicago satira L., alfalfa. SOLANACEAE—Lycopersicon esculentum Mill., tomato; N'ecotiana tabacum L., tohacco; N. glutinosa I.; N. langsdorffii Weinm.; N. rustica L.; N. sylvestris Spegaz. and Comes; Solanum tuberosum I., potato.

Geographical distribution: United

Induced disease: In red clover, yellow color along veins, but no mottling. Sometimes small yellow spots in interveinal areas. Little or no stunting. In Vicia faba, experimentally, necrotic splotches or rings sometimes at site of inoculation. Clearing of veins followed by appearance of whitish bands along the veins. Stalks discolored, purplish. Diseased plants are stunted and often die back to a point near the base of the stalk, inducing new growth from buds on the stem.

Transmission: By inoculation of expressed juice, using carborundum. By aphid, Macrosiphum pisi Kalt. (APUI-DIDAE), without incubation period and without long retention. Not by aphids, Macrosiphum solanifolii Ashm. (= M. gei Koch) or Aphis rumicis Linn. (APUIDIDAE)

Thermal inactivation: At 60° C in 10 minutes.

Literature: Osborn, Phytopath, 27, 1937, 1051-1058; Zaumeyer, Jour. Agr. Res., 56, 1938, 747-772; Zaumeyer and Wade, Phytopath., 27, 1937, 1009-1013.

31. Marmor pachyrhizi spec. nov. From New Latin Pachyrhizus, generic name of sincamas

Common name · Sincamas-mosaic virus.

Host: LEGUMINOSAL—Pachyrhizus crosus (L.) Urb., sincamas (yam
bean).

Insusceptible species: LEGUMINO-SAE-Phaseolus vulgaris L , bean Geographical distribution: Philippine Islands.

Induced disease: In sincamas, chlorotic mottling of foliage; in plants infected when young, dwarfing.

Transmission: By inoculation of expressed juice, in the presence of sand as abrasive. Through about 25 percent of the seeds from infected plants. Not through soil, interlacing of roots, or casual contacts of leaves and stems. No insect vector is known.

Literature: Fajardo and Marañon, Philippine Jour. Science, 48, 1932, 123-142.

35. Marmor viguae spec. nor. From New Latin Vigna, generic name of cowpea, from family name of an Italian botanist, Domenico Vigna.

Common name: Cowpea-mosaie virus. Hosts · LEGUMINOSAE-Vigna sinensis (L.) Endl., cowpea. Experimentally, also Phoseolus Iunatus L., lima bean.

Geographical distribution: United States (Arkaneas, Oklahoma, Louisiana, Indiana, Georgia, Iowa, Mississippi, Kansas, New Jersey).

Induced disease: In cowpea, clearing of veins followed by chlorotic mottling, slight convex emping of leaflets, short-ened internodes, abortion of lowers, twisting of petioles, delayed matunty. Malformation of leaves, stunding of plants, and reduction of yield more pronounced in some varieties of cowpea than in others.

Transmission: By inoculation of expressed juice, especially in the presence of fine carborundum powder. By aphibit. Macrosiphum solanifolii Ashm, M. pii Kalt., Aphis gossepii Glov. (APHIDIDAE); not by various beetles nor by the bean leathopper, Empossea fabor LeB. (CICADELLIDAE). Through 5 per cent of seeds from infected cowpen plants.

Thermal inactivation. At 72 to 75° C in 10 minutes.

Other properties: Infectious in dilutions as high as 1:1000 and after 2 days storage in expressed juice at room temperature, 20 to 25° C.

Laterature: Elliott, Phytopath., 11, 1921, 146-148, Gardner, Indiana Acad. Science Proc., 56, 1927, 231-247, 57, 1928, 417, McLean, Phytopath, 51, 1941, 420-430; Smith, Science, 60, 1924, 268.

36. Marmor repens Johnson (Phytopath., 32, 1942, 114.) From Latun repens, unlooked for, in reference to unexpected discovery of this virus as a constituent of a complex formerly regarded as a single virus, so-called "white-clover mosaie virus".

Common name : Pea-wilt virus.

Hosts LEGUMINOSAE—Trifolium repens L., white clover. Experimentally, also Lathyrus odoratus L., Lens esculenta Noerela.; Lupinus albus L., Medicogo lupulina L., Melilotus alba Destr., Phaseolus aureus Roxb., muug bean, Peralparis L., bean, Pisum satieum L., pea. Trifolium hybridum L., T. incarnatum L., T. pratense L.; Vieng faba L., V. satita L.; Vigna sinensis (L.) Endi.

Insusceptible species CARYOPHYL-LACEAE-Stellaria media (L.) Cyrill CHENOPODIACEAE-Beta pulgaris L. Spinacia oleracea L. COMPOSI-TAE-Callistephus chinensis Nees, Lactuca satua L.; Taraxacum officinale Weber, Zinnia elegans Jaca, CRUCI-FERAE-Barbarea vulgaris R Brassica oleracea L., Raphanus sativus I. CUCURBITACEAE-Cucumis satiens L. GRAMINEAE-Zea mans L. LEGUMINOSAE-Glycine max Merr . Lupinus hirsulus L. Medicago salira 1. LILIACEAE-Lalium formosanum PLANTAGINACEAE-Plan. Stanf tago lanccolata L . P major L POLY-CONACEAE-Rumer acetosella SCROPHULARIACEAE - Anterhinum majus I. SOLANACEAE-Datura stramonium L. Lycopersicon esculentum Mill , Nicotiana glutinosa L ; N rustica L. N. subestris Sperse and Comes, \ tabacum L., Solanum nearum L

Geographical distribution: United States (Washington).

Induced disease. In white clover systemic chlorotic mottling In pea, experimentally, originally infected leaves wilt and die, remaining attached to the stem by their shriveled petioles; a few adjacent lower leaves may also wilt and die: in most varieties the top foliage remains green, but in two varieties, Alaska and Canada White, it mottles faintly, stems show faint gravish discoloration; plants are retarded in growth and dwarfed. If nea-mottle virus, Marmor efficiens Johnson, is also present, a severe streak disease occurs Intracellular inclusions ab-In mung bean, experimentally, necrotic zonate local lesions In cowpea. experimentally, brown necrotic local lesions in inoculated primary leaves. diffuse areas of bleaching in uninoculated trifoliate leaves In bean, experimentally, mild chlorotic mottling except in three varieties that appear insusceptible (varieties Ideal Market, Kentucky Wonder, and Navy Robust).

Transmission By inoculation of expressed junce Not by dodder, Cuscula campestris Yunch (CONVOLVULA-CEAE) Not by pea aphid, Macrosphum piss Kalt (APHIDIDAE). No insect vector is known

Thermal inactivation At 58 to 60° C in 10 minutes

Filterability Passes Berkefeld W filter

Other properties Infectious in dilution of 1.100,000. Not inactivated by storage in juice of infected plants at about 25° C for one month or by similar storage in dried trisues of infected pea plants.

Literature Johnson, Phytopath, 52, 1942, 103-116, Pierce, Jour Agr. Res. 51, 1935, 1017-1039

37 Marmor fastidiens spec non. From Latin fastidiens, disdaining, in reference to slight irregularities in the reported host ranges of constituent strains and failure of this virus to infeccettain varieties of the pea although it may utilize many other varieties of this species as host.

Common name: Alsike-clover mosaic virus.

Hosts: LEGUMINOSAE—Trifolium hybridum L., alsike clover; Pisum safinum L., pen (except the varieties HoraPerfection, and Surprise). Experimentally, also Crotalaria striata DC.; C.
retusa L.; and C. speciabilis Roth (the
two last-named species are reported to be
insusceptible to the type strain of the
virus, but susceptible to one or more of
the other tested strains); Lupinus abus
L.; L. angustfolius L.; Medicago sativa
L.; Medilotus alba Dest.; Phascolus vulgaris L., bean; Trifolium incarnatum L.;
T. pratense L.; Veca foba L.

Insusceptible species: SOLANA-CEAE-Datura stramonium L.; Nicotiana glauca Graham; N. glutinosa L.; N. tabacum L.; Petunia hybrida Vilm. LEGUMINOSAE-Phaseolus aureus Roxb., mung bean; P. lundus L., sieva bean; Soja max (L.) Piper, soybean; Trifolium repens L., white clover; Vicia satira L., spring vetch.

Induced disease. In pea and bean, experimentally, systemic chlorotic mottling; some isolates kill inoculated leaves and even cause death of infected plants.

Transmission. By inoculation with expressed juice, at dilutions to 1:6000 or 1:8000 No insect vector is known.

Thermal mactivation · At 60 to 65° C in 10 minutes; one strain at lower temperature, 54 to 58° C.

Strams. Several strams have been distinguished by the severity of their effects on host plants. These may be characterized as follows: var. fastidiens, var. nov., type variety, the first of the strains to be described (originally known as alsike clover mosaic virus 1), induces mild disease in pea, does not infect red clover; var. mite, var. nov., described as pea mosaic virus 4, induces mild symptoms on pea, infects red clover; var. reprimens, var nov., described as pea mosaic virus 5, stunts peas severely; var. denudans, var. nov., described as alsike clover mosaic

virus 2, defoliates pea plants. Varietal names from New Latin fastidiens, epithet of the species, and from Latin mitis, mild; reprimere, to restrain; and denudare, to denude; all three in reference to induced symptoms.

Literature: Wade and Zaumeyer, Phytopath., 28, 1938, 505-511; Zaumeyer, Jour. Agr. Res., 60, 1940, 433-452.

38. Marmor iners spec. nov. From Latin iners, sluggish or inert, in reference to failure of the virus to spread systemically in certain of its hosts.

Common name: Pea-streak virus.

Hosts: LEGUMINOSAE-Pisum saturum L., pea. Experimentally, also

Dest.; Lupinus angustifolius L., blue lupin; L. luteus L., yellow lupin; L. mutobils Sweet; Phaseolau sulgaru L., bean; Trifolium arrense L., haresloot trefoil; T. cernuum Brot., nodding clover; T. fragyferum L., strawberry clover; T. spomeratum L., cluster clover; T. kpbrdum L., alsike clover; T. rapanse L., red clover; T. repens L., white clover i Vuis vuloss Roth., hairy vetch. CUCUB-BITACEAE—Cucums melo L, tock melon; C. saticus L., cucumber; Cucumbita nepa L., marrow.

Insusceptible species: CHENOPODI-ACEAE-Spinacia oleracea L., spinach, Beta vulgaris L , beet. COMPOSITAE -Calendula officinalis L , calendal; Lactuca sain a I., lettuce; Zinnia elegans Jacq , zinnia. CRUCIFERAE-Brasssca napus L , swede; B oleracea L , cabbage; B. rapa L , turnip; Matthiola incana R Br., stock; Raphanus sativus L., radish, Sisymbrium officinale (L.) Scop, LEGUMINOSAEhedge mustard Arachis hypogaea L , peanut; Lathyrus lutifolius L , perennial sweet pea; L. pubescens Hook, and Arn., Argentine sweet pea; Lotus corniculatus L.; Lupinus arboreus Sims, tree lupin; Medicago arabica Huds ; M. sativa L., lucerne (alfalfa); Phaseolus multiflorus Willd., runner bean: Trifolium striatum L . striated clover . T. subterraneum L., subterranean clover; Vicia faba L., broad bean PLANTAGINACEAE -Plantago lanceoluta L., plantain, SCROPHU-LARIACEAE-Antirrhinum masus L. SOLANACEAE-Cuphomandra betacea Sendt., tree tomato: Datura stramonium L , Jimson weed; Nicotiana glauca R Grah : N rustica L., Turkestan tobacco : N. tabacum I., tobacco, Physalis peruviana L., Cape gooseberry; Solanum nigrum L , black nightshade. TROPAE-OLACE AE-Tropacolum manus L . nas-UMBELLIFERAE-Apium turtium grancolens L., celery.

Geographical distribution New Zea-

Induced disease. In the pea, stunting, wilting of young leaves, purple or purplebrown spotting on young leaves, dark streak on stem Near tip, stem may die Stem becomes brittle, tip bent to one side Pods may remain flat and turn dark purple or purple-brown, or if already formed may show purple or purple-brown markings. Older leaves turn vellow. then brown and shrivelled. Infected plants usually die within two or three neeks In inoculated plants small brown primary lesions, rapidly increasing in size especially along veins, eventually involve the whole leaf; petiole and stem streak follows Among garden peas, the varietics Pride of the Market, Little Marvel. Wm Massey and Autocrat are little affeeted; among field peas, the varieties Unica and White Ivory are equally reasin cucumter, experimentally, numerous brown, necrotic local lesions, each with light colored center and sur rounding light-yellow halo. In bean, experimentally, local and systemic neero tacld lo diesh, death arms, rea

Transmission By inoculation of expressed junce, best with an abrasive powder such as fine sand. Not by Myzus persicae (Sule), Macrosiphum solani (APHIDIMAE), nor Thrips tobact Lind. (THRIPIDAE). No insect vector is known. Thermal inactivation: At 78 to 80° C in 10 minutes.

Filterability: Passes Mandler filters of preliminary, regular, and fine grades.

Other properties: Dilution end point 1:10. Not inactivated at room temperature in 41 days.

Literature Chamberlain, New Zealand Jour. Science and Technology, 20, 1939, 365A-351A.

39. Marmor efficiens Johnson. (Phytopath., 32, 1912, 111.) From Latin efficiens, effective, in reference to ability of this virus to cause mottling in all tested varieties of pea in contrast with nability of pea-wilt virus, a second constituent of the complex earlier known as "whiteclover mosaic virus," to produce such chlorotic symptoms in tested varieties other than Alaska and Canuda White.

Common name Pes-mottle virus.

Common name Pes-mottle virus.

Li gud II Sum INOSAE—Trifsium repeas L., white clover, Pisum settleum L., pea. Experimentally, also CLRYO-PHYLLACEAE—Stellara meda (L.) Cyrilt. CHENOPODIACEAE—Spinacia oleracea L., spinach. CUCURBITACEAE—Cheumus satinus L. LE-GUMINOSAE—Lathyrus odoralus L.; Lens exculenta Moench., Luprana albus

eulgaris L., bean; Trifolium hybridum L., T., incarnatum L., T., pratense L.; Vicia foba L., V satira L. SCRO-PHULARIACEAE—Antirrhinum manas V.

Insusceptible species CHENOPODI-ACEAE—Bita valgaris L., sugar beet, COMPOSITAE—Calistephus chinensis Nees, Lactura satrea L., Tarazacum offirunte Weier, Zumm elegous Jaca, CRUCIFERAE—Barbarea valgaris R. Br., Brassaco eleraca L., Raphanus satrea L. GRAMINEAE—Zee mays L. LEGUMINOSAE—Gigene max Metr., Vigna success (L.) Judil. LILI-ACEAE—Litum formoranum Stapt. PLANTAGINACEAE — Plantago PLANTAGINACEAE — Plantago lanccolata L.; P. major L. POLYGON-ACEAE-Rumex acctosella L. SOLAN-ACEAE-Datura stramonium L.; Lycopersicon esculentum Mill.; Nicotiana glutinosa L.; N. rustica L.; N. sylvestris Spegaz. and Comes; N. tabacum L.; Solanum nigrum I.

Geographical distribution · United States (Washington).

Induced disease: Experimentally, in pea, developing leaves late in opening; clearing of veins, chlorotic spotting, stunting, chlorotic mottling; stipules mottled; stems, pods, and seeds appear normal. If pea-wilt virus (Marmor repens Johnson) is also present, a severe streak disease occurs. Intracellular inclusions absent. In bean, light yellow spots and clearing of veins. In spinach, severe chlorotic mottling, dwarfing. In alfalfa, streaks of yellowing along veins, chlorotic mottling.

Transmission By inoculation of expressed juice. By dodder, Cuscula campestris Yunek. (CON VOLV ULACEAE). Not by pea aphid, Macrosiphum pisi Kalt. (APHIDIDAE). No insect vector is known.

Thermal mactivation At 60 to 62° C in 10 minutes.

Filterability · Passes Berkefeld W filter candle.

Other properties: Infectious in dilution of 1:10,000 and after storage in expressed juice or dried tissues for one month at about 25° C.

Literature Johnson, Phytopath, 32, 1942, 103-116; Johnson and Jones, Jour Agr. Res., 54, 1937, 629-633, Pierce, ibid., 51, 1935, 1017-1039; Zaumeyer and Wade, ibid., 51, 1935, 715-749.

40. Marmor tritici H. (loc. cit., 61). From Latin triticum, wheat.

Common names Wheat-mosaic virus, wheat-resette virus.

Hosts: GRAMINEAE—Triticum aestivum L., wheat, Secale cereale L., rye. Experimentally, also all tested species of the tribe Hordeae; Triticum compactum Host; T. turgidum L.; T. durum Desl.;

T. dicoccum Schrank; T. spella L.; T. polonicum L.; T. monococcum L., Hordeum vulgare L., barley.

Insusceptible species: GRAMINEAE

Bromus inermis Leyss., awnless bromegrass (of the tribe Festuceae).

Geographical distribution, Hand

Geographical distribution: United States, Japan.

Induced disease: In wheat, systemic chlorotic mottling, with dwarfing in some varieties; vacuolate, rounded intracellular bodies in diseased cells, usually close to nucleus. Some selections of Harvest Queen wheat are resistant.

Transmission: Through soil, remains infectious in soil for more years. By inoculation of expressed julce (needle punctures in stem). Not through seeds or stubble of diseased plants. No insect vector is known.

Thermal inactivation: Contaminated soil becomes incapable of infecting wheat plants if heated for 10 minutes at 60° C though not if heated for the same length of time at 50° C.

Literature: Johnson, Science, \$5, 1942, 610, McKinney, Jour. Agr. Res., £5, 1923, 771-800; U. S. Dept. Agr., Bull. 1361, 1925; U. S. Dept. Agr., Girc. 442, 1937; Jour. Agr. Res., £9, 1930, 547-585; McKinney et al., bid. £9, 1933, 657-585; McKinney et al., bid. £9, 1933, 657-585; McKinney et al., bid. £9, 1933, 657-585; McKinney et al., bid. £9, 1934, 1978-1978. [Rev. Appl. Mycol., £1, 1935, 618, Abst.], Jour. Lup. Agr. Erp. Sta., \$1, 1937, 93-128 (Rev. Appl. Mycol., £6, 1937, 655, Abst.); Webb, Jour. Agr. Res., £5, 1927, 537-614; 56, 1932, 53-75.

41 Marmor graminis McKinney. (Jour. Washington Acad Sci., 54, 1944, 325) From Latin gramen, grass.

Common name: Brome-grass mosaic

Hosts: GRAMINEAE.—Bromus incrmis Leyss., awiless brome-grass. Experimentally, also Triticum aestirum L., wheat; Avena sativa L., oat.

Geographical distribution United States (Kansas).

Induced disease: In awaless bromegrass, systemic chlorotic mottling of the type commonly called yellow mosaic because of the distinctly yellow color of the chlorotic areas in affected leaves.

Transmission: By inoculation of expressed juice or of aqueous suspensions of dried diseased tissues; not inactivated by drying in diseased tissues for at least 51 days. No insect vector is known.

Literature: McKinney et al., Phytopath., 32, 1942, 331,

42. Marmor abaca H. (loc. cit., 63). From common name of host plant.

Common name: Abacá bunchy-top virus.

Host MUSACEAE-Musa textilis

Insusceptible species: MUSACEAE— Musa sapientum L. vars. einerea (Blanco) Teodoro, compressa (Blanco) Teodoro, lacatan (Blanco) Teodoro, and suarcelens (Blanco) Teodoro, M. catendishii Lamb.

(Blanco) Teodoro, M. carendishis Lamb. Geographical distribution: Philippine Islands.

Induced disease In abora (Manula hemp plant), chlorotic lines and spots along veins of young leaves, followed by growth of distorted leaves, successively shorter, narrower, stiffer, and more curled along their margins. The green areas of mottled leaves, petioles, and leaf sheaths are darker than normal. Newly formed diseased leaves unfurl early, but are short, producing the bunchy top that is referred to in the common name of the disease.

Transmission By the aphid, Pentalonia ingronerrosa Con. (APHIDI-DAE), vector also of the apparently distinct binana bunchy-top virus of Australia. The inculuation period of alactaliant is necessary to the property of virulferous aphids do not receive the virus directly, but must feed on diseased plants before they can infect healthy alaca. Transmission by inoculation of expressed jutce has not been demonstrated. No soul transmission.

Literature. Ocfemia, Am. Jour. Bot.,

17, 1930, 1-18; Philippine Agriculturist, 22, 1934, 567-581.

43. Marmor passiflorae H. (loc. cil., 77). From New Latin Passiflora, generic name of passion fruit.

Common name · Passion-fruit woodi-

Hosts: PASSIFLORACEAE—Passiflora edulis Suns, passion fruit; P. coerulea L. Experimentally, also P. alba Lank and Otto.

Insusceptible species: SOLANA-CEAE—Datura stramonium L.; Lycopersicon esculentum Mill., tomato; Nicotiana alutinosa L.; N. tabacum L., tohacco.

Geographical distribution: Australia (New South Wales, Queensland, Victoria), Kenya.

Induced disease In passion fruit, growth checked; leaves puckered, slightly chlorotic or obscurely mottled, curled, twisted, deformed. Clearing of veins has been observed. Color of stems darker green than normal in some places. Fruits short or deformed, discolored, surface sometimes roughened by cracks; so hard as not to be cut through readily. Pericarp or rind of fruit abnormally thick. Pulp deficient, color deepened. At temperatures below 50° F, some abscussion of young chlorotic leaves; above 50° F, masking of the disease; inove thanks.

Transmission By inserting cotton in stem wound after soaking it in expressed junce of diseased plant. By aphids, Myzus persicae (Sulz.), Macrosiphum solanifolis Aslim., and two dark-colored species of the genus Aphis (APHIDIDAE).

Laterature Cobb, Agr. Gaz. New South Wales, 12, 1901, 407-418, Noble, Jour. and Proc. Roy Sec. New South Wales, 62, 1928, 79-95, Noble and Noble, ibid., 72, 1939, 293-317; Smmonds, Queensland Agr. Jour., 45, 1936, 322-330

44. Marmor flaccumfacters II. (loc. cit., 73). From Latin flaccus, flabby, and facers, to make.

Common names Rose-wilt virus, rose dieback virus,

Hosts: ROSACEAE-Rosa hybrids, roses.

Geographical distribution: Australia, especially Victoria; New Zealand; possibly Italy,

Induced disease: In rose, leaflets crowd ed, brittle, recurved. Defoliation progresses from tip to base of plant. Tips of branches discolor and die back an inch or two. Stem darkens at base. Buds remain green and begin development, but growth is soon checked by necrosis at tips. Plant may recover temporarily, but not permanently.

Transmission: By inoculation of expressed juice (needle-puncture and scratch methods). No insect vector is known.

Filterability Passes Scitz filter (Scitz EK Schichten type, size 6).

Literature: Gigante, Boll. Staz. Pat. Veg. Roma, n. s. 16, 1936, 78-91; Grieve, Austral. Jour. Exp. Biol. and Med. Science, 8, 1931, 107-121; Jour. Dept. Agr. Victoria, 1932 and 1933, pages 30-32.

45. Marmor rosae H. (loc. cit., 74). From Latin rosa, rose.

Common name: Rose-mosaic virus.

Hosts ROSACEAL—Rosa rugosa

Thunb.; R. chimensis Jacq, var. manelli

Dipp.; R. mullifora Thunb; R. odorata

Sweet, tea rose; R. symnocarpa; Rubus

parinforus Nutt.

Geographical distribution: United States, England, Bulgaria, Brazil,

Induced disease: In Rosa rugosa and R. chinensis var. manelli, systemic chlorotic mottling.

Transmission: By budding and other forms of graftage. Not by inoculation of expressed juice. No insect vector is known.

Literature Baker and Thomas, Phytopath, 32, 1942, 321-326; Brieriey, Phytopath, 25, 1935, 8 (Abst.); Brieriey and Smith, Am. Nurseryman, 72, 1949, 5-3; Jour. Agr. Res., 61, 1940, 1825-860; Kramer, Revista de Agricultura, 15, 1940, 301-311; O Biologico, 6, 1940, 385-383, McWhorter, U. S. Dept. Agr., Plant Dis. Rep., 15,

1931, 1-3; Milbrath, West. Florist, 13, 1930, 22-30; Nelson, Phytopath., 29, 1930, 1930 (Abst.); Newton, Rep. Domia. Det., 1930, Div. Bot., Canad. Dept. 4gr., 1931, 23; Thomas and Massey, Hilgardia, 14, 1930, 615-663; Yıbert, Jour. Soc. Imp. et Cent. Hort., 9, 1863, 144-145, White, Phytopath., 22, 1932, 53-69; 24, 1934, 1124-1125.

46. Marmor venentierum II. (loc. cit, 75). From Latin venentier, poisonous, in reference to occasional killing of tissues near inserted bud in graft transmission.

Common name: Rose-streak virus. Hosts: ROSACEAE—Rosa multifora Thunb.; R. odorala Sweet; Rosa hybrids. Geographical distribution: Eastern United States.

Induced disease: In various rose species and hybrids, brownish or reddish triggand veinbanding patterns on leaves, and rug patterns on stems. Sometimes necrotic areas near inserted bud, causing girdling of stem and wilting of foliage.

Transmission: By grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Brierley, Phytopath., 25, 1935, 7-8 (Abst.); Brierley and Smith, Jour. Agr. Res., 61, 1940, 625-660.

47. Marmor mall H. (loc. cit., 75). From Latin malus, apple tree.

Common name. Apple-mosaic vrus.
Hosts: ROSACEAE—Pyrus malus L.,
apple. Experime etally, also Coincasie
harrociana; Erwoorya panonca Lindi,
loquat: Photonia arbutfolia Lindi,
toyon; Rosa sp., rose; Sorbus pallecent.
Insusceptible species: ROSACEAE—

Amelanchier alnifolia Nutt.; Crataequs douglasi Lindl.; Pyrus communis L., pear.

Geographical distribution: United States, Australia, Bulgaria, British Sies-Induced disease: In apple, clearing of

reins and systemic chlorotic spotting.

The chlorotic areas sometimes become necrotic during months of intense sunlight.

Transmission: By grafting No insect

possessing polar flagella. Gram-negative. Gelatin colonies Small, finely granular, fluorescent with dark center, surrounded a yellow zone, with pale gray margin. Some konietin stab: Dirty-white surface IN CITEDS becoming greenish, fluorescent

'ction. Protects diarnies: Circular, raised, smooth, ad include levine at "ntire, with fluorescent zone (Salla dientif G in Priphery.

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157, 74, Become charges 1, fluorescent

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Broth Moderate turbidity. Dirty Legion sequinent No bellule. aterials; water

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Potato Scant, olive green growth

Nitntes produced from artestes

Blood serum lique Sed in 5 days Aerobic, facultative

Optimum temperature Z.C.

13 Prendomonat oleopotant Lee and Chandler. (Jour Bact, 41, 1941, 55.) Short rade 0.5 by 0.3 to 1.5 microre.

occurring much and in land Multipe listening, lobed Celetin stab % Liquidaction office a reenish color. hitish sediment.

Litmus milk: Not coagulated. Potato: Glistening. reddish-brown growth.

Indole not formed. Nitrites produced from nitrates.

Aerobic, facultative. Optimum temperature 20°C.

Distinctive characters: Resembles Pseudomonas viscosa Migula. Source: Found in water and soils in

Kent, England. Habitat: Water and soil,

24. Pseudomonas ovalis Chester. (Bacillus fluorescens oralis Ravench Memoirs Nat. Acad. Sci., 8, 1896, 9; Chester, Determinative Bacteriology, 1901, 325; not Bacillus ovalis Wright, Memoirs Nat. Acad. Sci., 7, 1895, 435.) From ovum, egg; M. L. oval.

Rods: 0.3 to 0.7 by 0.7 to 1.3 microns. occurring singly. Motile, possessing a single polar flagellum. Gram-negative. Gelatin colonies: Irregular, lobate,

slightly granular.

Gelatin stab: No liquefaction.

Agar colonies: Circular, opaque, entire, greenish fluorescence.

Agar slant: Thick, white, becoming greenish, fluorescent.

Broth: Turbid, with pellicle.

Litmus milk: No coagulation; alkaline. Potato: Luxuriant, dirty-brown. Indole not formed.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Blood serum not liquefied.

Acid from glucose. Acrobic, facultative

Optimum temperature 25°C.

Habitat: Soil. Has been found in intestinal canal.

Pseudomonas striata Chester. (Bacıllus striatus viridis Ravenel, Memoirs Nat. Acad. Sci., 8, 1896, 22; Chester, Determinative Bacteriology, 1901, 325.) From Latin, strio, streak, groove.

Slender rods, of variable lengths, stain-

canes remain short and become resetted.

Transmission; By aphids, principally

Amphorophora rubi Kalt., but also A. rubicola Oestl. and A. sensoriata Mason (APHIDIDAE). Not by inoculation of expressed juice.

Literature: Bennett, Michigan Agr. Exp. Sta., Techn. Bull. 89, 1927; 123. [1932; Cooley, New York Agr. Exp. Sta. (Geneva), Bull. 675, 1936; Harris, Jour. Pom. and Hort. Science, 11, 1933, 237-255; 17, 1940, 318-343; Rankin, New York Agr. Exp. Sta., Geneva, Bull. 543, 1927; New York Agr. Exp. Sta., Geneva, Tech. Bull. 75, 1931.

Marmor persicae H. (Holmes, loc. ct., 81; Flavamacula persicae McKinney, Jour. Washington Acad. Science, 34, 1944, 149.)
 From New Latin Persica, former generic name of peach.

Common name Peach-mosaic virus.
Hosts: ROSACEAE—Prunus persica
(L.) Batsch, peach and nectarine, all
tested varieties. Experimentally, also
P. armenaca L., apricot; P. communis
Fritsch, almond; P. domestica L., plum
and prune.

Insusceptible species: Attempts to infect sweet and sour cherries have thus far failed.

Geographical distribution: United States (Colorado, California, Utah, Oklahoma, Texas, New Mexico, Arizona).

Induced disease In peach, short internodes in spring growth, sometimes breaking in flower pattern, chlorotic mottling and distortion of foliage early in season, masking of leaf symptoms or excision of affected areas of leaf lamina in midsummer; fruit small, irregular in shape, unsalable. Some peach varieties are less damaged than others, but all are thought to be equally susceptible to infection, and equally important as reservoirs of virus when infected. In almond, experimentally, symptomiess infections; symptoms appear in some apricot and plum varieties when experimentally infected, not in others.

Transmission · By budding and other

methods of grafting. Not by inoculation of expressed juice. Not through soil. No insect vector is known. Not through pollen or seed from diseased plants.

Thermal inactivation: Not demonstrated; virus not inactivated by temperatures effective in inactivating peach-

yellows virus.

Literature: Bodine, Colorado Agr. Exp. Sta., Bull. 421, 1936; Bodine and Durrell, Phytopath., 31, 1941, 322-333; Cation, 5td., 24, 1934, 1380-1381; Christof, Phytopath. Ztschr., 11, 1938, 350-422; Cochran, California Cultivator, 37, 1940, 164-165; Cochran and Hutchins, Phytopath., 28, 1938, 809-892; Hutchins, 84-ence, 76, 1932, 123; Hutchins et al., U. S. Dept. Agr., Circ. 427, 1937, 48 pp.; Kunkel, Am. Jour. Bot., 25, 1936, 685-685; Phytopath., 28, 1938, 491-497; Thomas and Rawlins, Hilgardia, 14, 1930, 623-644; Valleau, Kentucky Agr. Exp. Stan, Bull. 327, 1932, 89-1497.

52. Marmor astri H. (loc. cil., S). From Latin astrum, star. Common name: Peach asteroid-spot

virus.

Host: ROSACEAE-Prunus persica (L.) Batsch, peach.

Geographical distribution: Califorais. Induced disease: In peach, discrete chlorotic lesions spreading along veizs, forming star-like snots; developing leaves normal in appearance, becoming affected as they mature. Some chlorophyll retained in lesions as leaves turn yellow. Affected leaves shed early

Transmission: By grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Cochran and Smith, Phytopath., 28, 1938, 278-281.

53. Marmor rubiginosum Reeves. (Phytopath., 50, 1940, 789.) From Latin rubiginosus, rusty.

Common name: Cherry rusty-mottle

Host: ROSACEAE-Prunus arium L, sweet cherry.

vector is known. Transmission by inoculation of expressed juice has not been demonstrated.

Thermal inactivation: Not demonstrated. Virus in stem tissues withstands at least 50° C for as much as 60 minutes without being inactivated.

Literature: Blodgett, Phytopath, 28, 1933, 937-938; Bradford and Joley, Jour, Agr. Res., 46, 1933, 901-908; Christoff, Phytopath. Zeitschr., 7, 1934, 521-536; 8, 1935, 285-296, Thomas, Hilgardea, 10, 1937, 551-558.

48 Marmor fragariae II. (loc. cit., 78) From New Latin Fragaria, generic name of strawberry, from Latin fraga, strawiserres.

Common name. Strawberry-erinkle

Hosts ROSACEAE—Fragaria hybrids, cultivated strawberries. Experimentally, also Fragaria iesca L., woodland strawberry.

Geographical distribution United States, England.

Induced disease In cultivated strawberry, ernkling and chlorosis of leaves At first, minute chlorotic flecks appear in young leaves. These flecks enlarge, and small necrotic spots may appear in their centers. Vein-clearing appears frequently. Affected foliage lighter and less uniformly green than normal. The variety Royal Fovereign may appear normal through carrying this virus.

Transmission By aphid, Myzus fragarfolii Ckli (= Capitophorus fragariae Theob) (APHIDIDAE) By grafting. Not by inoculation of expressed juice.

Laterature: Harris, Ann. Rept. Last Malling Res. Sta. for 1936, 1977, 201-212, 212-221, ibid., for 1977, 1938, 201-202, Harris and Hildebrand, Canad Jour. Res., C. 16, 1977, 292-290, Qukive et al., Ann. Rept. Long Ashton Res. Sta. for 1973, 1931, 50-67, Vaughan, Phytoprib. 25, 1933, 73-710, Zeller, Oregon Agr. Exp. Sta., Sta. Bull. 319, 1931; Zeller and Vaughan, Phytopsth. 22, 1932, 700-713. 49. Marmor marginans II. (loc. cit, 79). From Latin marginare, to provide with a margin.

Common name: Strawberry yellowedge virus.

Hosts. ROSACIAE—Fragara hydrologida, stamberries, Fragara californica C. and S. F. chiloenvis Duch. (symptom-less). Experimentally, also Fragara eleca L; F. rapninan Duch. (some clones appear to be immune to infection by runner inarchine).

Geographical distribution. United States, England, France, New Zealand. Induced disease: In stray berry, plant

Induced disease: In strawberry, plant appears flat with outer zone of leaves more or less normal, central leaves dwarfed, yellow-edged, deficient in red pigmentation. The variety Premier may carry this virus without showing any obvious manifestation of disease.

Transmission By aphid, Myzus fragacfolii Ckll. (APHIDIDAE). By grafting. Not by inoculation of expressed purce. Not through seeds from diseased plants.

Laterature: Chamberlain, New Zealand Jour. Agr., 49, 1931, 226-231, Harris, Jour. Pom. and Hort. Science, 11, 1933, 59-76, Harris and Hildebrand, Canad. Jour. Res. 6, 16, 1937, 22-2269; Hildebrand, tbrd., C, 19, 1911, 223-233; Plakidas, Phytopath., 16, 1926, 423-420, Jour Agr. Res., 58, 1927, 1037-1037.

 Marmer rubi H. (Holmes, loc. ett., 50, Poccile rubi McKinney, Jour. Washington Acad. Science, 54, 1944, 148.)
 From Latin rubus, bramble bush.

Common name · Red-raspberry mosate

Hosts. ROSACEAE-Rubus adaeus L., red raspberry; R. occidentalis L., black rispberry.

Geographical distribution: United States

Induced disease 'In red raspherry, aysteme chlorotic mottling, masked at high temperatures of summer. Foliage development delayed in spring. In some varieties, leaf petules and cane tim die. chlorotic bands surrounding discolored areas on leaves. In Mazzard cherry, dwarfing of whole plant, chlorotic bands on leaves.

Transmission: By budding, even in the absence of survival of inserted buds.

57. Marmor nerviclarens Zeller and Evans. (Phytopath., 51, 1941, 467.) From Latin tervus, sinew or nerve, and clarere, to shine.

Common name: Cherry vein-clearing virus.

Hosts. ROSACEAE—Prunus assum L., sweet cherry. Perhaps also P. serrulata Lindl. and P. domestica L., on which symptoms similar to those induced by this virus have been observed.

Geographical distribution: United States (Oregon, Washington).

Induced disease: In sweet cherry, clearing of veins throughout each leaf or only in localized areas. Margins of leaves irregular, most indented where clearing of veins is most conspicuous. Elongated. elliptic, or slot-like perforations occur in some leaves. Affected leaves usually narrow. Enations occur as small blistered proliferations on lower side of main veins. Upper leaf surface silvery by reflected light. By midsummer, leaves droop and appear somewhat wilted; they may fold along the midvein. Internodes stort; increased number of buds, spurs, or short branches at nodes, rosetting more pronounced on some branches than on others, mostly at end of year-old wood. In advanced disease, fruits pointed, small, flattened on suture side with swollen ridge along suture. Blossoms abnormally abundant, crop of fruit reduced or wanting.

Transmission By grafting. Not demonstrated by inoculation of expressed juice. No insect vector is known.

58. Marmor viticola H. (loc cit., 83). From Latin vitis, vine, and -cola, inhabitant of.

Common name Vine-mosaic virus.

Host: VITACEAE—Vilis vinifera L.,
grape.

Geographical distribution: France. Italy, Bulgaria, Czechoslovakia,

Induced disease: In grape, various modifications of systemic chlorotic mottling, and red pigmentation of parts of leaves with subsequent drying and dropping out of affected spots. Leaves deformed, crimped between main veins Growth restricted.

Transmission: By inoculation of expressed juice and by pruning.

pressed junes and by pruning.
Literature: Blating, Vinnfaky obzor,
25, 1931, 4-5 (Cent. f. Bakt., II Abt., 26,
1931, 4-64); Ochrana Rostlin, 15, 1933,
104-105 (Rev. Appl. Mycel., 13, 1934,
221); Gigante, Boll. Staz. Pat. Veg. Roma,
ns. 17, 1937, 109-192 (Rev. Appl. Mycel,
17, 1933, 221); Pantanelli, Malpudus, 24,
1911, 497-523; 25, 1912, 17-46, Strmak, 1I
Congr. Intern. Path. Comp. Paris, 1832,
267-378; Ochrana Rostlin, 11, 1931,
89-98 (Rev. Appl. Mycel., 11, 1932,
293; Vielwerth, Ochrana Rostlin, 15, 1933,
38-90 (Rev. Appl. Mycel., 13, 1931,
421-422).

59. Marmor santali II. (loc. cal., 94). From New Latin, Santalum, generic name of sandal.

Common name: Sandal leaf-curl virus. Host. SANTALACEAE-Santalum album L., sandal.

Geographical distribution: India.
Induced disease: In sandal, lears small, curled, wrinkled, thickened, brittle, abscissing. Systemic chlorotic mettling. Internode length normal. Infected twigs produce both flowers and fruits.

Transmission: By ring back-grafts Not by inoculation of expressed juice. No insect vector is known.

Literature: Venkata Rao, Mysore Sandal Spike Invest. Comm., Bull. 3, 1933.

60. Marmor secretum Bennett, (Phytopath., 34, 1944, 88). From Latin secretus, hidden.

Common name: Dodder latent-mostic

Hosts - CONVOLVULACEAE - Cuscula californica Choisy, dodder. Experi-

Geographical distribution: United States (Washington).

Induced disease: In sweet cherry, chlorotic mottling 4 to 5 weeks after till bloom, first on small basal leaves, later on all leaves. The older affected leaves develop autumnal colors and absclss, 30 to 70 per cent of the foliage being lost. The remaining foliage appears somewhat wilted, shows increased mottling, chlorotic spots, and areas becoming yellowsh brown, appearing rusty. Blossoms normal. Fruits smaller than normal, inspid, not misshapen. Growth rate of tree reduced slightly.

Transmission. By grafting. Not by moculation of expressed juice. No insect

vector is known.

Literature. Recves, Phytopath., 50, 1910, 789 (Abst.); Jour. Agr. Res., 62, 1911, 555-572 (see 566-567).

54 Marmor cerasi Zeller and Evans. (Phytopath, 31, 1941, 467.) From Latin cerasus, cherry tree; originally spelled cerase, by error

Common name. Cherry mottle-leaf

Hosts ROSACEAE—Prunus arium L., sweet cherry, P. emarginala (Dougl.) Walp, wild cherry. Experimentally, also P. cerasus L. (tolerant) and P. mehalth L. (tolerant).

Geographical distribution. United States (Washington, Oregon, Idaho, Califorms) and Canada (British Columbia).

Induced disease. Insweet clierry, chlorotte mottling, leaves puckered, winkled, distorted, not perforated. Blossoms not affected Fruit small, hard, inspird, uneven or delyed in ripening. Crop reduced. Branches shortened, tree eventually stunted

Transmission By budding. No insect vector is known. Not by the black cherry aphid, Myrus cerasi (F.) (APHI-DIDAE). Not by inoculation of expressed junc

Thermal inactivation. Not demon strated, not at 46° C in 60 minutes nor at 49° C in 10 minutes in bud sticks.

Literature: Reeves, Washington State Hort. Assoc. Proc., 31, 1935, 85-89; Jour. Agr. Res., 62, 1941, 555-572; Zeller, Oregon State Hort. Soc. Report, 26, 1934, 92-95: Phytopath., 31, 1941, 463-467.

55 Marmor lineopictum Cation (Phytopath., 51, 1911, 1009.) From Latin linea, line, and pictus, ornamented. Common names: Prunus line-pattern

virus, peach line-pattern virus.

Hosts. ROSACEAE—Prunus salicina Lindl., Japanese plum, P. mahalto L., Mahaleb cherry; P. persica (L.) Batsch, peach (= Amygdalus persica L.).

Geographical distribution: United States (Kentucky, Michigan, California, Ohio: perhaps widely distributed).

Induced disease. In peach and Maladeb cherry, light-colored line patterns or faint chlorotic mottling, tending to become masked as leaf becomes old. In peach, affected foliage sometimes less glossy than normal. In Prunus solicina, no disease manifestations usually, rarefy, chlorotic mottling on a few leaves.

Transmission · By grafting. No insect vector is known.

Literature. Berkeley, Div. of Bot. and Plant Path., Science Service, Dominion Dept. Agr., Ottwa, Canada, Publ. 679, 1911; Cation, Phytopath., 31, 1911, 1001-1010, Thomas and Rawlins, Hilgardia, 12, 1939, 623-641; Valleau, Kentucky Agr. Exp. Sta., Res. Bull. 327, 1932, 89-103.

56, Marmor pallidolimbatus Zeller and Milbrath. (In Handbook of Yırus Discases of Stone Fruits in North America, Michigun Agr. Lvp. Sta., Miscell. Publ., May, 1942, 50, Phytopath., 32, 1912, 635.) From Latin pallidus, pale, and Imbatus, brodered.

Common name Cherry banded-chloro-

Hosts: ROSACEAE-Prunus serrulata Lindl., fowering cherry: P. arium

L , Mazzard cherry.

Geographical distribution: United
States (Pacific Northwest).

Induced disease: In flowering cherry,

Laubert, Gartenwelt, 31, 1927, 391; Pape, ibid., 26, 1927, 329-331; 32, 1928, 116-117; Pethybridge and Smith, Gard. Chron., 92, 1932, 378-379; Schmidt, Gartenwelt, 81, 1932, 49; Seliger, Nachrichtenbl. Deutsch. Pflanzenschutzdienst, 6, 1926, 63-64; Tuimann, Gartenwelt, 31, 1927, 375-376; Verplancke, Bul. Cl. Sci. Acad. Roy. de Belgique, Ser. 5, 18, 1932, 269-281 (Rev. Appl. Mycol., 11, 1932, 649-650).

Marmor angliae H. (loc. cit., 48).
 From Latin Anglia, England.

Common name: Petate-paracrinkle virus.

Hosts: SOLANACEAE—Solanum tuberosum L., potato. Experimentally, also Datura stramonium L., Jimson weed. Insusceptible species: SOLANA-CEAE—Nicotiana labacum L., tobacco. Geographical distribution: England.

Induced disease: In potato, masked in all plants of the variety King Edward. Chlorotic mottling with some necrosis in the varieties Arran Victory and Arran Chief. Chlorotic mottling only in Arran Commde, Majestie, and Great Scot potates. Two varieties, Sharpe's Express and Epicure, are said to be resistant.

Transmission: By grafts. Not by inoculation of expressed juice. No insect vector is known.

Literature: Dykstra, Phytopath., 26, 1936, 597-696; Salaman and Le Pelley, Proc. Roy. Soc. London, Ser. B, 196, 1930, 140-175.

63. Marmor aevi spec. nov. From Latin aevum, old age, in reference to the obvious involvement of old, but not of young, delphinium leaves.

Common name. Celery-calice virus.
Hosts: CUCURBITACEAE—Cucumis satirus L., cucumber; C. melo L., cantaloupe; Cucurbita pepo L., summer crookneek squash. RAN UNCULA-CEAE—Delphinium chanensis; D. formosum, hardy larkspur, D. grandyforum; D. parryi; D. zalti. SOLANACEAE—Lycopersicon esculentum Mill., tomato.

UMBELLIFERAE—Apium graveolens L., celery. Experimentally, also SOLA-NACEAE—Nicotiana tabacum L., tobacco; Petunia hybrida Vilm., petunia. VIOLACEAE—Viola cornula L

Geographical distribution. United

Induced disease: In celery, clearing of veins, puckering and downward cuping of younger leaves, green islands of tissue in lemon-yellow areas of outer leaves, green and yellow zigzag bands on teadet In delphinium, basal and middle leaves with pale-orange, amber, or lemon-yellow areas; younger leaves normal green, elloprotie ring and line patterns.

Transmission: By inoculation of expressed juice in the presence of finely powdered carborundum. By aphids: Aphis apigracolens Essig, celery lef aphid; A. apni Theob., celery sphig, A. ferruginea-strata Essig, rusty-banded aphid; A. gossupris Glov., cotton aphid; A. middletoni: Thomas, erigeon rot aphid; All grans circumflexus (Buck), hily aphid; M. convolenti (Kalt.), forgove aphid; M. perstace (Sult.), pren peach aphid; M. perstace (Sult.) pren peach aphid; M. perstace (Sult.) pren peach aphid; M. perstace (Sult.) pren peach aphid; M. perstace Sult. p

Literature. Severin, Hilgardia, 14, 1942, 441-461; Severin and Freitag, Phytopath., 25, 1935, 891 (Abst.); Hilgardia, 11, 1938, 493-558.

64. Marmor rathanl spec. nov. From Latin raphanus, adish.

Common name Raduh-mosaic virus Hosts CR CGIFERAE—Raphanus saturus L., radivih. Experimentally, site CRUGIFERAE—Brassea oleraeca L.; B. nugra (L.) Koch; B. eiba (L.) Boiss, B. graensis (L.) Kite.; B. petsai Builer; B. juncea (I.) Coss; B. rapa L.; B. dipressa Boiss, Capsella buran-gasiaris (L.) Medie; Malcomia maritima R. Br.; M. bicornis DC. CHENOPODIAGEAE. Chenopodium album L.; C. nurus L.; Spinacia oleraeca L. RANUNGULA. CEAE—Delphinum ajoas L. SOLA. NACEAE—Nicotiana glutinosa L.; N.

mentally, also CHENOPODIACEAE-Bela vulgaris L , sugar beet; Chenopodium album L., lamb's quarters; C. murale L., sowbane, CONVOLVULA-CEAE-Cuscuta campestris Yuncker: C. submedusa Dur. and Hile. CRUCI-FERAE-Erassica incana (L.) F. W. Schultz, mustard (tolerant). CUCUR-BITACEAE-Cucums melo L., cantaloune. PHYTOLACCACEAE-Phytolacca americana L., pokeweed. PLAN-TAGINACEAE-Plantago major L . plantain. POLYGONACEAE-Fagonurum esculentum Moench, buckwheat; Polygonum pennsylvanicum L. knotweed PRIMULACEAE-Samolus floribundus HBK., water pimpernel. SOLANACEAE-Lucopersicon esculentum Mill., temato, Nicotiana glauca Graham (tolerant); N. palmeri Gray; N. rustica L. (tolerant); N. tabacum L. (tolerant): Solanum tuberosum L., potato. UMBELLIFERAE-Aprum aratrolens L., celery.

Insureptuble species: COMPOSITAE—
Hichanthur annuus L., sunflower; Lactuca satua L., lettuce. CRUCIFERAE
—Brassica olerace, t., cabbage. POLYGONACE.I.E—Erroponum Jasciculatum
Benth, California bucksheat. SCROPHULARIACELE—Verbaseum thapsus L., mullen. SOLANACEAE—
Attomo belladonna. L., belladonna.

Geographical distribution United States (California).

Induced disease: In dodder, no symptoms. In sugar beet, experimentally, temporary systemic chlorotic spotting; occasional faded areas in leaves in subsequent chronic stage of disease. In cantaloupe, experimentally, chlorotic spotting, reduction in leaf sure, death of some leaves, atunting of plant; melons small and of poor quality. In celery, experimentally, systemic chlorosis followed by dwaffing and mottling with subsequent suparent recovery.

Transmission By dodder, Cuscuta californica, C. campestris, and C. subinclusa. By inoculation of extracted juice to some, but not to other, best plants, Phytolacca americang is readly infected by rubbing methods in the presence of asmall amount of abrasive, and develops numerous necrotic primary lesions that serve for quantitative estimation of concentration of virus in inoculum. Through seeds from infected plants of dodder, Cuacuta campetris; not through seeds from diseased cantaloupe, buckwheat, or pokeweed plants. No insect vector is known. Thermal unactivation: At 56 to 66° C.

in 10 minutes.

Filterability: Passes celite and Berkefeld N and W filters.

Other properties: Infective in dilutions to 1:3000. Inactivated by drying and by storage in expressed pokeweed juice, within 48 hours.

Marmor pelargonil spec. nov.
 From New Latin Pelargonium, generic name of common geranium.

Common names Pelargonium leaf-curl virus, virus of dropsy or Kräuselkrankheit of geranium.

Host GERANIACEAE-Pelargontum hortorum Bailey, geranium.

Induced disease In geranium, circular or irregular chlorotic spots, sometimes stellate or dendritic, § 10.5 mm in diameter, centers becoming brown with chlorotic border; severely selected leaves become yellow and drop; spotted leaves ruffed, crinkled, mallormed, small, sometimes puckered and splitting. Petioles and stems show coxly, raued, necrotic streaks; topy may die. Disease most severe in spring, inconspicuous in summer.

Transmission: By grafting. Not by moculation of expressed juice nor by use of knile to prepare cuttings for propagation. Not through seed. No insect vector is known.

Literature: Berkeley, Canad. Hort. and Home Mag., 1983, 1933, 1-1; Blatting, Ochrina Rostlin, 13, 1933, 145 (Rev. Appl. Mycol., 15, 1934, 237-370); Bremer, Blumen-u. Pflanrentau, 43, 1933, 32-33 (Rev. Appl. Mycol., 12, 1933, 514); Halitted, New Jersey Agr. Exp. Sta., Rept. 14, 1853, 422-433; Jones, Washington Agr. Exp. Sta., Bull. 390, 1910; fig; F. altissima Blume; F. krishna; and F. tsiela Roxb.

Geographical distribution: United States (California, Texas), England, Puerto Rico, China, New South Wales, Western Australia.

Induced disease: In fig, systemic chloroide spating and mottling of foliage; some severe leaf distortion. Fruits sometimes affected, bearing light circular arcas, rusty spots, being deformed or dropped prematurely. Necrotic lesions on profich of Samson captifigs also have been attributed to action of this virus.

Transmission. By budding. No insect vector is known; mites have been suspected as possible vectors.

Literature: Condit and Horne, Phytopath., 23, 1933, 837-896; 51, 1941, 561, 563; 55, 1913, 719-723, Honad Li, Lipgnan Science Jour., 15, 1936, 69-70; Pittman, W. Austral. Dept. Agr. Jour., 12, 1935 196.

67. Marmor Italicum (Fawcett) comb nov. (Cetruri italicum Fawcett, Phytopath., 31, 1911, 357.) Specific epithet meaning "pertaining to Italy."

Common name Citrus infectious-mottling virus.

tling virus.

Hest: RUTACEAE—Curus aurantum L., sour orange.

Geographical distribution: Italy.

Induced disease. In sour orange, white, pale green, or yellow irregular areas in leaves, leaving narrow green bands along midrib; leaves blistered and distorted.

Transmission: The aphid, Toxoptera aurantii (Phytopath., 24, 1934, 661), has been suspected as vector. Literature: Fawcett, Phytopath., 5t, 1941, 356-357; Petri, Bol. Staz. Pat. Veg. Roma, n. s. 11, 1931, 105-114.

Note: Several additional species were described too late for complete systematic treatment here. They are plain's wheat mosaic virus. Marmor campestre McKinney (Jour. Washington Acad. Sci., \$4, 1944, 324) with varieties typicum McKinney and galbinum McKinney, respectively causing light-green mosaic and severe yellow mosaic of wheat in Kansas; wheat streak-mossic virus, Marmor virgatum McKinney (ibid., 54, 1944, 324) with varieties typicum Mckinner and viride McKinney (shid., 54, 1944, 325), respectively causing vellow streskmosaic and green streak-mosaic of wheat in Kansas; Agropyron-mosaic virus, Marmor agropyri McKinney (shid., 34, 1944, 326), with varieties typicum McKinney and florum McKinney, respectively causing green-mosaic mottling and yellow-mosaic mottling in the grass Agropyron repens (I...) Beauv. in Virginia; also a virus, Flavimacula ipomese Doolittle and Harter (Phytopath., 35, 1945, 763), causing feathery mottle of sweet potato in Maryland [see Marmer persions for treatment of a virus that was assigned as type of Flavimarula McKinney (Jour. Washington Acad Sci. \$4, 1914, 149), a genus originally differentiated from Marmor as containing viruses not yet inoculable save by tissue union; a natural group of viruses may be represented but their characteristics and affiliations seem not yet clear).

Genus II. Acrogenus Holmes.

(Loc. cit., 110.)

Viruses of the Spindle-Tuber Group, inducing diseases characterized by abnormal growth habit of host plants without chlorotic or necrotic spatting, systemic chloroff, witches'-broom formation, or production of galls. Generic name from Greek, meaning point- or peak-producing, in reference to shape of potatoes affected by potato spindle-tuber virus.

The type species is Acrogenus solani Holmes.

United

langsdorffii Weinm.; N. rustica L.; N.

Geographical distribution: States (California),

Induced disease: In radish, systemic chlorotic spotting followed by chlorotic mottling of foliage; little or no leaf distortion; plants not stunted.

Transmission: By inoculation of expressed juice No insect vector is known, not by the cabbage aphid, Brevicoryne brassicae (L.); the false cabbage

seeds from diseased radish plants.

Thermal inactivation At 65 to 68° C in 10 minutes.

Literature: Tompkins, Jour. Agr. Res., 58, 1939, 119-130.

 Marmor primulae spec. nov. From New Latin Primula, generic name of primrose.

Common name. Primrose-mosaic virus.

Hosts PRIMULACEAE—Primula
obconica Hance Experimentally, also
P. malacoides Franch and P. sinensis
Lindl.

Insusceptible species · BEGONIA-CEAE-Begonia semperflorers Link and Otto BORAGINACEAE-Myorotis alpestris Schmidt. CAMPANULA-CEAE-Campanula medium L. CARY-OPHYLLACEAE-Dignthus burbatus CHENOPODIACEAE-Spingera oleracea 1. COMPOSITAE-Bellis perennis L., Callistephus chinensis Nees. Gerbera jamesonii Hook , Lactuca satira L. Senecio cruentus DC., Tagetes patula L. CRICIFERAE-Brassien oleracen L. B pe tran Buley , B. rapa L. , Matthi ola incana R Br., Raphanus satirus L CI CURBITACEAE-Cucumis sativus L., Cucurbita pepo L. EUPHORBIA-CEAE-Ricinus communis L. GRAM-INEAE-Zea mays L LEGUMINO-SAE-Pisum satirum I. , Vicia faba L , Vigna sinensis (Torner) Sivi LO-BELLIACEAE-Lobelia hybrida Hort. PAPAVERACEAE Paparer orientale sensis L .: Cuclamen indicum L .: Primula auricula L.; P. veris L. RANUNCU-LACEAE-Anemone coronaria L : Delnhinium cultorum Voss: Ranunculus RESEDACEAE-Reseda assaticus L. odorata L. ROSACEAE-Geum chiloense Balb SCROPHULARIACEAE-Anterrhinum majus L.. Pentstemon barbatus Nutt. SOLANACEAE-Capsicum frutexcens L . Datura stramonium L .: Lucopersicon esculentum Mill .: Nicotiana glutinosa L.; N tabacum L., Solanum tuberosum L. TROPAEOLACEAE-Tropacolum majus L. UMBELLI-FERAE-Anum graveolens L. VER-

PRIMULACEAE-Anagallis ar-

BENACEAE—Verbena hybrida Voss. VIOLACEAE—Viola tricolor L. Geographical distribution United States (California).

Induced disease. In Primula obconica, chloronis, Author, with upward, or occasionally downward, cupping of leaves. Petioles and peduncles shortened, flowers reduced in size, broken in color (white-streaked). Leaves coarsely mottled with yellow-green, leaving green islands, tips of leaves sometimes marrowed.

Transmission: By moculation of expressed june, in the presence of 600 mesh powdered carborundum. Not by aphids, Myzus persicae (Sulz.) and M. erreumferus (Buck.) (APMIDID.ID) No insect vector is known. Probably not through seeds

Thermal inactivation: At 50° C, not 45° C, in 10 minutes

Other properties Infective after 21, not 48, hours in ritro. Infective after 1 10 dilution

Laterature Tompkins and Middleton, Jour Agr Res , 63, 1911, 671-679

66. Marmor cariene (Condit and Horne) comb. nov. (Ficture caricae Condit and Horne, Phytopath., 51, 1911, 563.) From Latin carica, a kind of dried fig.

Common name Fig-messic virus.
Hosts: MORACEAE-Ficus carica L.,

ing and rolling of leaves. Foliage leathery. Sometimes conspicuous phloem necess. Generic name from Latin corium, leather.

The type species is Corium solani Holmes,

## Key to the species of genus Corlum.

- I. Infecting potato.
- II. Infecting beet.
- III. Infecting raspberry.
- Corium solani Holmes. (Handb. Phytopath. Viruses, 1939, 120.) From New Latin Solanum, generic name of potato.

Common name Potato leaf-roll virus. Hosts: SOLANACEAE Solanum tuberonum L., potato. Experimentally, also other solanaceous species, Datura stramonium L., Jimson weed; Lycopersicon esculentum Mill., tomato; Solanum dulcamara L., bittersweet, S. villosum.

Insusceptible species: CHENOPODI-ACEAE—Bela vulgaris L., beet.

Geographical distribution: North America, France, British Isles, probably wherever potatoes are grown.

Induced disease In potato, leaves thick, rigid, leathery, and rolled, their starch content excessive. Plants dwarfed. Tubers few, small, crisp. Tubers of some varieties show conspicuous phloem necrosis, germinate with spindling sprouts.

Transmission: By aphid, Mysus persicae (Sulz.) (APHIDIDAE), with neu-bation period of 24 to 48 hours. Also by Mysus convolvult (Kalt.) (= M pseudo-solani Theob.), M. circumflexus (Buckt.), Macrostphum solanifolii Ashm., and Aphis abbreviate Patch (APHIDI-DAE). By grafting. Not by inoculation of expressed juice.

Literature Artschwager, Jour. Agr. Res., 16, 1918, 559-570; 24, 1923, 237-245; Dykstra, tbid., 47, 1933, 17-32, Elze, Phytopath., 21, 1931, 675-686, Folsom, Maine Agr. Exp. Sta., Bull. 297, 1921,

- 1. Corium solani.
- 2. Corium betae.
- 3. Corium rubi. 4. Corium ruborum.

37-52; Al0, 1942, 215-250; Murphy, Scient. Proc. Roy. Dublin Soc., 17, 1923, 163-184; Murphy and M'Kay, 1643, 19, 193, 341-353; Schulfr and Folsom, Jour. Agr. Res., 21, 1921, 47-50; Smith, Ann. Appl. Biol., 16, 1929, 209-229; 18, 1631, 141-15; Stevenson et al., Ann. Potato Jour., 20, 1943, 1-10.

 Corium betae spec. nov. From Latin beta, beet.

Common names: Sugar-beet yellows virus, beet-yellows virus, jaunisse virus, vergelingsziekte virus.

Hosts: CHENOPODIACEAE—Bels vulgaris L., beet; B. maritum L.; B. cicla; Atriplez hortensus L., A. sburet L.; Chenopodum album L., lamb's quaters; Spinaca aleroca L., spinach AMARANTHACEAE —Amarankss retrosterus L.

Insusceptible species: SOLANA-CEAE-Solanna, tuberosum L., potato; all other tested solanaceous species

Geographical distribution: Belgium, Netherlands, Denmark, England; perhaps Germany and the United States.

Induced disease: In beet, young leaves little affected; older leaves yellow, but tle, short, thick, containing excessive amounts of ear-bohydrates; necrois in secondary phloem. In spinach, yellowing, necrosis between veins on old leaves

Transmission: Not by inoculation of expressed juice. By aphids, Myrus persicae (Sulz.), Aphis Jabae Scop., Macasiphum solanifolii Ashm., and Aulacor-

#### Key to the species of genus Acrogenus.

- I. Infecting potato.
- II. Infecting black current.
- · ·

1. Acrogenus solani Holmes. (Handb. Phytopath. Viruses, 1939, 111.) From New Latin Solanum, generic name of potato.

Common names: Potato spindle-tuber virus, potato spindling-tuber virus, potato marginal leaf-roll virus.

Host: SOLANACEAE-Solanum tuberosum L., potato.

Geographical distribution: United States and Canada.

Induced disease: Plants creet, stiff, spindly, lacking vigor. Leaves small, erect, darker green than normal. Peti-oles sometimes slender, brittle. Tubers long, cylindricaf, firregular in shape, tapered at ends, smooth and tender-skinned, of softer than normal flesh in spring Eyes of tuber conspicuous.

Transmission: By inoculation of expressed juice, by use of contaminated kindio in cutting successive tubers before planting; by contacts of freshly cut seed pieces. By aphids, Mysus persions (Sulz.) and Macrosiphum solanifolin Ashm. (- M. per Koch) (APHIDIDAE). Also by certain leaf-stute insects.

Thermal inactivation: At 60 to 65° C in 10 minutes (in tuber tissues).

Literature: Bald et al., Phytopath., 51, 1911, 181-185; FdSum, Maine Agr. Dvn. Sta, Orene, Bull. 312, 1923, Gov., Phytopath., 16, 1929, 233, 299-303; 18, 1923, 415-448; Nebrasha Agr. Exp. Sta., Res. Bull. 47, 1930, 55, 1931; Jaczewski, La Défense des Flantes, Leningrad., 4, 1927, 62-77 (Rev. Appl. Mycol., 6, 1927, 572-573, Abst.); McLeod, Canad. Exp. Farms, Div. Bot., Rpt. for 1923, 1927.

1. Acrogenus solani.

2. Acrogenus ribis.

Strains: A strain causing unmottled curly dwarf of potato has been given a varietal name to distinguish it from the type, var, vulgaris H. (loc. cit., 111).

1a. Acrogenus solani var. severus II. (loc. cit., 112). Inducing symptoms in potato on the whole more severe than those caused by the type strain.

Common name: Unmottled curly-dwarf strain of potato spindle-tuber virus, (Goss, Nebruska Agr. Exp. Sta., Res. Bull. 47, 1930, 53, 1931; Schultz and Folsom, Jour Agr. Res., 25, 1923, 43-118.)

2. Acrogenus ribis II. (loc. est., 112). From Latin ribes, currant.

Common name Black-current reversion-disease virus.

Host · SAXIFRAGACEAE-Ribes nigrum L., European black currant.

Geographical distribution. British

Induced disease: In European black currant, leaves abnormally narrow and flat, small veins few. Flowers sometimes nearly transparent, smooth, sepals brightly colored beneath. Flowers and small fruits fall. Stems less woody than normal, with tendency to excessive gum production.

Transmission. By grafting. By bigbud mite, Eriophyes ribit (ERIOPHYI-DAE). Not by inoculation of expressed junce. Not through coil. Not through seeds from diseased plants.

Laterature Amos and Hatton, Jour. Pom. and Hort. Science, 6, 1926, 167-183; Amos et al., in East Mulling Res. Sta., 15th Ann. Rpt., 1923, 43-65; Lee, Ann. Appl Biol., 9, 1933, 49-68.

Genus 111. Corlum Holmes.

(Loc. cit , 119.)

Viruses of the Leaf-Roll Group, inducing diseases usually characterized by thicken-

geniculatus, p.p. of geniculo, knotted. iointed.

Medium-sized rods, occurring singly, in pairs and chains, motile, possessing polar flagella. Gram-negative.

Gelatin colonies: Circular, whitish. translucent. Deep colonies vellowish.

Gelatin stab: Infundabuliform liquefaction. Sediment light pink.

Agar slant: Gravish, glistening, translucent, limited, becoming brownish-gray. Broth: Turbid, with slight gray pellicle and sediment.

Litmus milk: Alkaline: reduction of

litmus: slight coagulation. Potato: Thin, brownish, moist, glistening, viscid.

Indole not formed.

Nitrites not produced from nitrates. Aerobic, facultative,

Optimum temperature 20° to 25°C.

Habitat · Water.

32. Pseudomonas fragi (Eichholz) Huss emend. Hussong, Long and Hammer. (Bacterium fraga Eichholz, Cent. f. Bakt., II Abt., 9, 1902, 425; Huss, Cent. f. Bakt., II Abt., 19, 1907, 661, Hussong. Long and Hammer, Iowa Agr. Exp. Sta. Res. Bull 225, 1937, 122; also see Long and Hammer, Jour. Dairy Sci., 20, 1937. 448) From Latin fragum, strawberry.

Description from Hussong, Long and

Hammer, loc. cit.

Rods 0 5 to 1.0 by 0.75 to 4.0 microns. occurring singly, in pairs and in chains. Motile with a polar flagellum, Gramnegative.

Gelatin · Crateriform to stratiform liquefaction in 3 to 4 days.

Agar colonies Convey, glistening, generally butyrous, occasionally viscid. Rough, smooth and intermediate forms are recognized in the description quoted. The rough forms are less proteolytic, and less active in the hydrolysis of fats. Agar slant: Growth abundant, spread-

ing, raised, white, shiny, generally butyrous. Sweet ester-like odor resembling that of the flower of the May apple.

Broth: Turbidity and sediment with a thin pellicle.

Litmus milk: Acid ring followed by acid coagulum at surface. Complete coagulation in 2 to 3 weeks, some digestion. Characteristic May apple or strawberry odor.

Potato: Growth echinulate to arborescent, raised, glistening, white, becoming brownish.

Indole not produced.

Nitrites not produced from nitrates. Ammonia produced from pentone. Hydrogen sulfide not produced.

Acid from glucose and galactose, sometimes arabinose. No acid from glycerol, inulin, lactose, fructose, maltose, mannitol, raffinose, salicin and

SUCTOSE. No acetylmethylcarbinol produced.

Fat is generally hydrolyzed. Aerobic.

Grows from 10° to 30°C. No growth at

37°C. Very sensitive to heat. Source: Isolated from milk and other

dairy products, dairy utensils, water, etc. Habitat: Soil and water. Widely distributed (Morrison and Hammer, Jour.

Dairy Sci., 24, 1941, 9). Hussong (Thesis, Iowa State College, 1932) regards Bacterium fragi Eichholz (loc. cit.) as the R type, Pseudomonas fragariae I Gruber (Cent. f. Bakt., II Abt., 9, 1902, 705) as the O form, and Pseudomonas fragariae II Gruber (Cent. f. Bakt , II Abt., 14, 1905, 122) as the S form of the same organism. He makes no mention of Pseudomonas fragaroidea Huss (loc. cit.) which from its description would belong to the smooth type A brief characterization of each of these organisms follows: (1) Bacterium fragi came from milk as drawn from an individual cow; it does not liquefy gelatin, exhibits no fluorescence, is strongly alkaline in litmus milk, and does not grow at 37°C, (2) Pscudomonas fragariae I came from fodder beets; it does not liquefy gelatin, has weak blue-greenish fluorescence, is weakly alkaline in milk, and grows at 37°C, (3) Pseudomonas fragariae II came from pasteurized milk;

it liquefies gelatin, coagulates milk, and

does not grow at 37°C, (4) Pseudomonas

thum solani Kalt. (APHIDIDAE): virus is not transmitted by these aphids to their descendants. Not through seeds of beet. Virus overwinters in bects stored for subsequent use in seed produc-

Serological relationships: Specific precipitating antiserum effective with crude sap of diseased, not healthy, plants and with sap of diseased plants after passage through a Chamberland La, not La filter candle: meffective with sap from beet plants suffering from mosaic

Thermal inactivation Virus heated to about 52°C no longer precipitates with specific antiserum

Literature: Kleezkowski and Watson, Ann. Appl Biol , 31, 1944, 116-120, Petherbridge and Stirrup, London, Ministry Agr, and Fisherics, Bull. 95, 1935, Quanier and Roland, Tridschr, Plantenziekten, 42, 1936, 45-70; Roland, abid., 45, 1939, 1-22, 181-203, Schreven, Meded, Inst. voor Suikerbietenteelt, Bergen on Zoom, 6, 1936, 1; Watson, Proc. Roy. Soc. London, Ser B, 128, 1940, 535-552. Ann. Appl. Biol., 29, 1942, 358-365.

3. Corium rubi H. (loc. est. 121). From New Latin Rubus, generic name of raspherry, from Latin rubus, bramble

Common name: Raspberry leaf-curl virus.

Host ROSACEAE-Rubus idaeus L., red raspberry.

Insusceptible species · ROSACEAE~ Rubus occidentalis L. black raspherry. R. neglectus Peck, purple raspberry.

Geographical distribution. United States, not in England.

Induced disease. In red raspherry, years retarded in growth, causing downward curling of leaf margins and crinkling of leaf lamina. Toliage durk green, dry in appearance, not wilting readily. In late summer, leaves bronzed, leaf surface glistening. Discused canes easily winterkilled Berries small and page. The English variety Lloyd George is intolerant of the disease and is killed.

Transmission: By aphid. Aphis rubicola Cesti. (= A, rubiphila Patch) (APHIDIDAE). Not by inoculation of expressed juice.

Literature Bennett, Michigan Agr. Exp. Sta., Tech. Bull. 80, 1927; Phytonath., 20, 1930, 787-802, Harris, East Malling Res. Sta., Ann. Rpt. for 1934. 1935, Rankin, New York Agr. Exp. Sta.. Geneva, Tech Bull, 175, 1931,

Strains: A strain differing from the type, var. alpha H. (loc, cit., 121), has been given a varietal name derived from its common name, raspberry beta-curl VITIES.

- 3a Corsum rubs var. beta H. (loc. cit., 122). Infecting black and purple manbernes, as well as the red raspberry, which alone is susceptible to the type strain, raspberry alpha-curl virus. (Bennett. Phytopath., 20, 1930, 787-802.)
- 4 Carium rubarum (Zeller and Braun) comb nov (Minuor ruborum Zeller and Braun, Phytopath., 53, 1943, 161.) From Latin rubus, bramble bush.

Common name Raspberry decline-discase virus

Host ROSACEAE-Rubus idaeus L. red raspberry.

Geographical distribution United States (Oregon)

Induced disease. In Cuthbert rasp. berry, shoots retarded in spring, reddish; leaves in autumn rolled downward, fluted along years, less green than portral between years, slightly bronzed along margins and crests between veins Internodes shortened near tips of canes. Affeeted canes small, weak, not hardy in unter Small roots and feeder rootlets fewer than in healthy plants. Discusse progressive over about three years. Fruits small, irregular, tending to be globose, crumbly when ripe, worthless.

Transmission: By grafting. No insect vector is known.

## Genus IV. Nanus Holmes,

(Loc. cit., 123.)

Viruses of the Dwarf-Disease Group, inducing diseases characterized by dwarfing of host plants or by growth of adventitious shoots with short internodes; chlorete mottling absent. Generic name from Latin natus, dwarf.

The type species is Nanus loganobacci Holmes.

## Key to the species of genus Nanus.

- I. Infecting resaceous plants.
  - A. In loganberry and Phenomenal berry.
  - B. In black raspberry.
  - C. In peach.
  - D. In ocean spray.
  - E. In strawberry.
  - F. In prune and plum.
- II. Infecting graminaceous plants.
  - A. In sugar cane.
- Nanus loganobacci Holmes. (Handb. Phytopath. Viruses, 1939, 124.)
   From New Latin loganobaccus, specific epithet of loganobarry, Rubus loganobaccus Bailey.

Common name: Loganberry-dwarf

Hosts. ROSACEAE—Rubus loganobaccus Bailey, loganberry and Phenomenal berry.

Geographical distribution: United States (Oregon, Washington, and California).

Induced disease In Phenomenal berry, leaves small, obovate, rigid, new canes short, spindly. In young plants, some necrosis along and between veins, leaves crinkled, finer veins chlorotic. Steen not streaked or mottled, normal in color. In late stages, canes very short, internodes short. Sepals and petals of flowers small. Fruit of fair size, but druplets ripen unevenly and tend to fall apart when picked. Loganberry is less susceptible than the Phenomenal berry but is similarly affected.

- Nanus loganobacci.
- 2. Nanus orientalis.
- 3. Nanus mirobilis.
- 4. Nanus kolodisci.
- 5. Nanus fragariae. 6. Nanus cupuliformans
- 7. Nanus pruni.
- S. Nanus sacchari.

Transmission: By aphid, Capitophorus tetrahodus (APHIDIDAE). Not by inoculation of expressed juice.

Literature: Zeller, Phytopath., 18, 1925, 732 (Abst.); 17, 1927, 629-618.

2. Nanus orientalis H. (loc. cd., 121). From Latin orientalis, castern.

Common names: Raspberry-streak virus, raspberry eastern blue-stem virus, raspberry rosette virus.

Host ROSACEAE—Rubus occidentolis L., black raspberry.

Insusceptible species: ROSACEAE— Rubus idaeus L., red raspberry; R. phoencolasius Maxim., Japanese wineberry. Geographical distribution: United

Induced disease: In black rapperty, plants stunted, becoming smaller in successive seasons; leaves usually curled, close together on canes, dark green, often twisted so as to be upside down. Ner canes show blush violet dots, gols, or stripes near their bases and sometimes also on branches or on fruiting spars.

Fruit inferior in size, quality, and quantity. Plants live only 2 or 3 years after injection on the average.

Strains: A strain of this virus is believed responsible for mild streak of black raspberries, in which purple to violet, greenish brown, or bluish streaks on canes are narrowly linear or elliptical in form and often very faint; when the bloom is rubbed off, the lesions appear as though watersoaked and discolored. Leaves are elightly curled, their veins cleared. Fruits are dry and dull in lustre, even while still red, and of poor flavor when rice.

Literature: Bennett, Michigan Agr. Exp. Sta, Tech Bull. 80, 1927, Wilcox U. S. Dept. Agr, Dept. Circ. 227, 1923, Woods and Haut, U. S. Dept. Agr, Plant Dis Rut. 24, 1910, 335-340.

3. Nanus mirabilis H. (loc. cit., 126). From Latin mirabilis, strange.

Common name: Peach phony-disease virus.

Hosts. ROSACEAE—Prunus persica (L.) Batsch, peach. Experimentally, also other Prunus species.

Geographical distribution: United States (Georgia, Alabama, Florida; aparsely als in Massissippi, Tennessee, South Carolina, Louisiana, Texas, Arkansas, Missouri).

Induced disease: In peach, tree dwarfed, foliage abnormally green, fruit small, flecks in wood, especially in roots, sections of roots show characteristic well-distributed purple spots after 3 to 5 minutes of treatment in 25 cc absolute methyl alcohol acidulated by the addition of 1 to 5 drops of concentrated, chemically pure hydrochlogic acid.

Transmission: By root grafting, except by root-bark patch grafts, which are ineffective. Budding and grafting with parts of stem fill to transpir this line.

of stem fail to transmit this virus.
Thermal inactivation: At 45° C in about

40 minutes in roots.

Literature: Hutchins, Georgia State Entomol, Bull, 78, 1933; Phytopath., 22, 1939, 12 (Abst.); Hutchins and Ruc, tbid., 22, 1939, 12 (Abst.). 4. Nanus holodisci H. (loc. cit., 127). From New Latin Holodiscus, generic name of ocean spray.

name of ocean spray.

Common name Ocean-spray witches'broom virus

Host · ROSACEAE-Holodiscus dis-

Geographical distribution: United States (Oregon and Washington).

Induced disease In occan-spray, diseased branches form clusters of thin wiry shoots with abnormally short internodes and crowded small leaves. Laterals numerous and more than normally branched. Bronzy red color acquired early by affected foliage.

Transmission By aphid, Aphis spuraces Schout. (APHIDIDAE). By grafting. Not demonstrated by inoculation of expressed wice.

Literature Zeller, Phytopath., 21, 1931, 923-925.

 Nanus fragariae H. (Holmes, loc. cit., 128; Blastogenus fragariae McKinney, Jour. Washington Acad Science, 34, 1944, 151.) From New Latin Fragaria, generic name of strawberry.

Common name: Strawberry witches's

Host: ROSAGEAE—Fragaria chiloensis Duch. var. ananassa Balley, cultivated strawberry,

Geographical distribution: United States (western Oregon).

Induced disease: In strawberry, leaves numerous, light in color, with spindly petioles, margins of leaflets bent down, runners shortened, plants dwarfed; flower stalks spindly and unfruitful; root systems normal and well developed.

Transmission: By aphis, Mysus fragasfolis Ckll. (APHIDIDAE). Not demonstrated by moculation of expressed

juice Literature. Zeller, Phytopath., 17, 1927, 329-335.

6. Nanus cupuliformans Zeller and Weaver. (Phytopath., 31, 1941, 851.) From diminutive of Latin cupa, tub, and participal from Latin formare, to form.

Strawberry-stunt name: Common virus.

Host: ROSACEAE-Fragaria chiloensis Duch, var. ananassa Bailey, cultivated strawberry.

United distribution: Geographical States (Oregon, Washington).

Induced disease: In strawberry, little if any reduction in chlorophyll, plants erect but short; leaves at first folded. later open, dull in lustre, with papery rattle when brushed by hand, leaflets cupped or with margins turned down, midveins tortuous; petioles 1 to 3 normal length; fruits small, usually hard and seedy; roots normal in appearance.

strawberry-leaf Transmission: By aphid. Capitophorus fragaefolii (APIII-DIDAE). By grafting. Not by inoculation of expressed juice.

7. Nanus pruni II. (loc. cil., 128). From New Latin Prunus, generic name of prune, from Latin prunus, plum tree. Common name . Prune-dwarf virus.

Hosts: ROSACEAE-Prunus domestica L., prune and plum; var. institia Bailey, the Damson plum, remains symptomless. Experimentally, also Prunus persica (L.) Batsch, peach.

Insusceptible species: ROSACEAE-Prunus avium L., cherry.

Geographical distribution; United States (New York); Canada (British Columbia, Ontario).

In prune, leaves Induced disease small, narrow, rugose, distorted, glazed. Internodes short. Some branches escape and appear normal. Blossoms numerous, mature fruits few. Pistils aborted, petals narrow and distorted. In Damson and Bradshaw plums, no obvious manifestations of disease as a result of infection.

Transmission: By budding and other forms of grafting. Not demonstrated by inoculation of expressed juice. No insect vector is known.

Literature: Berkeley, Canada, Domin. Dept. Agr., Div. of Bot. and Plant Path, Science Service, Publ. 679, 1941; Hildebrand, Phytopath., \$2, 1942, 741-751; Thomas and Hildebrand, Phytopath., 26, 1936, 1145-1148.

8. Nanus saccharl H. (loc. caf., 129). From New Latin Saccharum, generic name of sugar cane, from Latin saccharum, sucat.

Common name: Sugar-cane serehdisease virus.

Host: GRAMINEAE-Saccharum of cinarum L., sugar cane.

distribution: Geographical Borneo, Sumatra, Moluccas, India, Mauritius, Australia, Fiji, Formosa, Hawaii, Cevlon.

Induced disease: In sugar cane (Cheribon variety), plant dwarfed, shoots stunted, vascular bundles colored by the presence of a red gum; adventitious roots from many or all nodes.

Transmission: Not by inoculation of expressed juice. No insect vector is known.

Thermal inactivation: In cuttings of sugar cane, at 52° C in 30 minutes to 1 hour. Infected cane cuttings survive the heat treatment required for cure through inactivation of the causative virus.

Literature : Houtman, Arch. Suikerind. Nederland.-Indië, 35, 1925, 631-652; Lyon, Bull. Exp. Sta. Hawaiian Sugar Planters' Assoc., Bot. Ser., 3, 1921, 1-43; Wilbrink, Arch. Suikerind. Nederland Indië, \$1, 1923, 1-15.

Genus V. Rimocortius Mulbrath and Zeller.

(Phytopath., 52, 1942, 430.)

Viruses of the Rough-Bark Group, inducing diseases principally affecting bark, less often wood, leaves, or fruit. Generic name from Latin rama, cleft or fissure, and

The type species is Rimocortius kwanzani Milbrath and Zeller. cortex, bark.

(Norn: The genus Citrieir (first named species, Citruir psorosis Fawcett, Phytopath., 31, 1941, 357) was proposed by its author as a genus pro tempore with the avowed purpose of accommodating viruses causing diseases in species of the plant-host genus Citrus. It appears to have been implied by the term genus pro tempore that evidences of natural relationship, when discovered, would permit even the first-named species of this genus to be assigned elsewhere. On the assumption that a permanent genus is nothing more than a type species and such other species as may be added to it by one or another author, it must be felt that a genus pro tempore, however convenient as an expedient, cannot become a permanent genus under any circumstances, because its first-named species would appear not to be a permanent part of the genus and so intended not to be a true type-species Without a type species there would seem to be no permanent genus concept.

The system by which the term Citrieir was coined (explained by its author as use of the cepitive of the host-genus name. Citris, plus rir, signifying virus) seems in itself acceptable, for it is commonly agreed that a generic name may be made in an arbitrary manner. It may be noted that use of the stem of the host-genus name (Citr-) with connecting yowel ; and suffix -vir. possibly a more orthodox procedure, would have given the same result in the present instance. The original definition of the term Citrus might be thought to be repugnant as disregarding concepts of natural interspecific relationships that are essential to the spirit of binomial nomenclature. Were the genus to be regarded as permanent rather than pro tempore, however, the scope of the genus would come to be wholly changed by usage, when, with passage of time related species would be added to what in this case would be a type species, without regard to the unorthodox intent of the original definition but solely in accordance with similarities between viruses. A generic concept need never be accepted as rigidly defined, whether initially, as has been attempted in this case, or upon further experience, because a genus may still grow by the addition of closely allied new species beyond any limit that may be set. On this account an original, or any subsequent. definition may be regarded as subject to unlimited change so long as the type species is logically retained. The form and definition of the term Citrivir would not, therefore, militate against its continued use. Its avowedly temporary status alone seems decisively to do so.

The originally monotypic genus Rimocortius, published in the following year, was defined only by the combined generic and specific description, and was not referred to a family by its authors. The type, because at first the only species, Rimocortius kurazani, is the flowering-cherry rough-lark virus. This type species might well be associated with the species Clirius provous, extrus-provess virus, discussed above, both affecting both principally, though foliage also to some extent. Although the grouns Clirius was named in 1914 and Rimocortius not until 1924, the first was intended as a temporary assemblage only, as above indicated. It would seem appropriate, therefore, to include the virus that was known at emporarily as Clirius provincia in the permanent genus Rimocortius Milbrath and Zeller and to assign this genus to the family

#### Key to the species of the genus Rimocortius.

I Affecting cherry.

1 Rimocortius Lwanzani.

II. Affecting Citrus.

2. Rimocortius psorosis.

III. Affecting pear.

3. Rimocortius pyri.

1. Rimocortius kwanzani Milbrath and Zeller. (Phytopath., 52, 1942, 430.) From Kwanzan, name of a variety of flowering cherry.

Common name: Flowering-cherry

rough-bark virus.

Hosts: Prunus serrulata Lindl. var. Kwanzan, flowering cherry; P. avium L., Mazzard cherry.

Geographical distribution: United States (Oregon).

Induced disease: In flowering cherry, tree dwarfed, deficient in lateral branches; bark deep brown, roughened, splitting longitudinally; internodes shortened, bunching leaves; leaves arched downward; midribs of leaves split and cracked on under surface. In Mazzard cherry, no manifestation of disease, but carrier condition; budded Mazzard stock may transmit disease to healthy Kwanzan cherry clous.

Transmission: By budding, generally even if the inserted bud fails to survive. Literature: Milbrath and Zeller, Phytopath., 52, 1942, 428-430; Thomas, 101d.,

32, 1942, 435-436.

2. Rimocortius psorosis (Fawcett) comb. nov. (Citrur psorosis Fawcett, Phytopath., 51, 1941, 357) Specific name meaning "of the disease known as psorosis."

Common name: Citrus-psorosis virus. Hosts: RUTACEAE—Citrus suensis Osbeck, orange; C. limonia Osbeck, lemon; C. mazima Merr., grapefruit.

Geographical distribution World-wide

Induced disease In citrus, small, elongated, light colored areas or flecks in the region of small vens on young, tender foliage, leaves sometimes warped, (chlorotie?) clearing of veins, and chlorotie line patterns, sometimes concentric. Outer layers of bark scale away, depressions and deformities appear in bark and wood. Lemons, as a rule, are more tolerant than oranges and are not subject to the bark changes.

Transmission: By grafting, including root grafting and patch bark grafting. Not by inoculation of expressed juice. No insect vector is known.

Literature: Bitancourt et al., Phytopath., 35, 1913, 865-833; Fawcett, ibd., 24, 1934, 695-665; Science, 82, 1910, 565-561; Phytopath., 31, 1911, 336-337; Fawcett and Bitancourt, ibid., 35, 1913, 837-864; Rhoads, ibid., 38, 1912, 410-413; Webber and Fawcett, Hilgardia, 9, 1935, 71-190.

Strains: Three strains differing from the type have been recognized. The type, var. vulgare Fawcett, Phytoputh., 51, 1911, 357, causes psorosis A, the common scaly-bark type of disease, with pustular exquitions of outer layers of bark in limited areas, with or without exudation of gum; later a drab-gray, cinamond-drab to rulus discoloration of the wood, accompanied by decline of the affected tree. Others, that contrast with the type, are:

- 2a. Rimocortius psorosis var. anu'atum Fawcett. (Phytopath., 31, 1941, 351.) From Latin anudatus, with a ring. Causing psorosis B, known from California, tesembling zonate chlorosis of Brazil in effects on leaves and fruits. Psorosis B is characterized by rapid sealing of outer bark in continuous areas, progressing rapidly along one side of trunk or brateh; gum exudes in advance of scaling, accrosis follows; large circular discolored and corky spots, sometimes concentric, on fruits and mature leaves; on some fruits, circular or semi-circular furrows and bumps; rapid decline of the affected free
- 20. Rimacortius poorosis var. concarun
  Fawcett and Bitancourt. (Phytopath.,
  55, 1943, 830.) From Lain concave,
  concave. Causing concave-gum psomsis,
  characterized by concavities of various
  sizes on trunks and larger limbs of affected trees, often by zonate patterns on
  young leaves during periods of rapid
  growth.

2c. Rimocortius psorosis var. alecalum Fawcett and Bitancourt. (Phytopath, 35, 1913, 854.) From Latin alecatus, hollowed out like a trough. Causing bindpocket psorosis, characterized by troughlike pockets in bark and wood or by cruptive lesions.

3. Rimocortius pyri (Holmes) comb. nov. (Mormor pyri Holmes, Handb. Phytopath. Viruses, 1939, 76) From New Latin Pyrus, generic name of pear, from Latin pyrus, pear tree.

Common name: Pear stony-pit virus. Host: ROSACEAE-Pyrus communis

L., pear.

Geographical distribution: United States (Oregon, Washington, California).

Induced disease: In pear, fruit deeply putted and deformed; bark cracked and resembling oak bark; venilet chlorosis of some leaves, failure of lateral buds to grow, reduction of foliage. Bartlett and Comice varieties of pear appear to be tolerant, producing sound fruit from infected trees.

Transmission. By budding. Not by inoculation of expressed juice. No insect vector is known.

Literature · Kienholz, Phytopath., 29, 1939, 260-267, 50, 1940, 787 (Abst.).

### Genus VI. Adelonosus Brierley and Smith

(Phytopath., 54, 1944, 551.)

Viruses capable of multiplying in living plants but producing no recognizable symptoms in these except on interaction with distinct viruses with which they form complexes Transmitted by aphilds, by sap, or by both means Generic name from Greek addles, invisible, and noses, disease. Only one species is recognized thus far; this is the type species, Addenous like Direity and Smuth.

1. Adelonosus IIIII Brierley and Smith (Phytopath., 34, 1914, 551.) From Latin Islam, Isly

Common name: Lily-symptomicss

Host · LILIACEAE-Lilium longiflorum Thunb., Easter lily,

Insusceptible species. All other tested likes and many related plants in the same and other families (for list, see Phyto-

path., 34, 1914, 519).
Geographical distribution. United
States, Japan; probably coextensive with
commercial culture of Easter bly.

Induced disease: In Easter hly, no obvious manifestation of disease when this arms is present alone; when together with encumber-mosaic virus, however, the hly-symptomics virus is a determining factor in the production of ne-

crotic-fleck disease; the lily-symptomless virus is so widely distributed in supposedly healthy stocks of the Enster lily that encumber measer virus formerly was thought to be the sole determining factor in necrotic flecking, now recognized to be caused by the virus complex lity-symptomless virus (Addionaus liti) plus excuember, measie virus (Marmor encumeras), the complex acts independently of the presence or absence of lily latent-measer virus (Marmor mice), which is often present with the essential members of the complex in flecked Listet likes.

Transmission By inoculation of expressed juice, with some difficulty. By aphid, Aphis gossypii Glov., cotton aphid (APHIDIDAE); preinfective period after obtaining virus, 4 to 6 days.

#### FAMILY III. ANNULACEAE HOLMES.

(Handb, Phytopath, Viruses, 1939, 97.)

Viruses of the Ringspot Group, causing diseases usually characterized by necestar or chlorotic spotting with concentric-ring lesions and eventual recovery from obvious disense with non-sterile immunity. Hosts, higher plants; vectors unknown. There is a single genus.

### Conus I Annulus Holmes

(Loc. cit., 97.)

Characters those of the family. Generic name from Latin annulus, a ring. The type species is Annulus tabaci Holmes.

## Key to the species of genus Annulus.

- I. Found occurring naturally in the Western Hemisphere.
  - A. In tobacco.

- 1. Annulus tabaci.
- 2. Annulus zonatus.
- 3. Annulus orae. 4. Annulus aperius.
- B. In potato.
  - 5. Annulus dubius.

States.

C. In delphinium.

6. Annulus delphinii.

11. Old World species.

- 7. Annulus bergerac. Geographical distribution: United
- 1. Annulus tabaci Holmes. (Handb. Phytopath. Viruses, 1939, 98. Marmor anularium McKinney, Jour. Washington Acad. Sci. 34, 1914, 327.) From New Latin Tabacum, early generic name for tobacco

Induced disease: In tobacco, necrotic ring-like primary lesions, followed by secondary necrotic rings on younger leaves. Subsequently, affected plants recover. After recovery from obvious disease, virus content of plants is only 10 to 20 per cent of that of recently infected plants. Some varieties may show

Common names: Tobacco-ringspot virus, green ringspot virus, yellow ringspot virus, ring snot No. 1 virus.

mosaic-like patterns in young leaves at 16°C Transmission: By inoculation of evdressed juices. Through about 20 per cent of seeds from diseased petunia plants. Not by dodder, Cuscuta campestris Yuncker (CONVOLVULACEAE).

SOLANACEAE-Nicotiana tabacum L., Petunia violacea Lindl., Solanum tuberosum L. CUCURBITA-CEAE-Cucumis salivus L. Experimentally this virus has been found capable of infecting many species of plants in a large number of families; these include all tested species of the SOLANACEAE, SCROPHULARIACEAE, COMPOSIand CUCURBITACEAE. TAE. Many species of the LEGUMINOSAE are susceptible and one, Vigna sinensis (L.) Endl., is used as an indicator plant for quantitative measurement because it displays conspicuous reddish-brown necrotic lesions around points of imital

infection.

Serological relationships: Induces the formation of specific precipitating antibodies when injected into bloo.istream of rabbit.

Immunological relationships: Recovered tobacco plants are not susceptible to reinfection with this virus but are readily infected with Annulus zonatus or A. orac. This virus produces primary lesions on leaves of plants immune to reinfection with A. bergerac.

Thermal inactivation: At 68° C in 10 minutes.

Filterability: Passes V, N, and perhaps W Berkefeld filters.

Other properties: Particle size estimated by filtration experiments as about 19 millimicrons. Sedimentation constant, S<sub>28</sub> = 115 × 10<sup>-1</sup> em. sec. <sup>-1</sup> dyne<sup>-1</sup>. Infective in dilutions of 10<sup>-7</sup> after purification. Inactivated in 1 hour below pil 3 or above pil 10.8. Recovered plants of tobacco contain 0 002 mg of virus per gram, recently infected plants about 6 times as much. Optimum conditions for retaining infectivity of stored virus include suspension in 0.01 M phosphate buffer at pil 7 and storage at 4° C.

Literature Fenne, Phytopath, 21, 1931, 891-899; Fromme et al., sbid. 17. 1927, 321-328; Henderson, ibid , 21, 1931, 225-229, Henderson and Wingard, Jour. Agr. Res , 45, 1931, 191-207, Price, Contrib. Boyce Thompson Inst., 4, 1932. 359-403, Phytopath., 26, 1936, 503-529. Am. Jour Bot., 27, 1910, 530-511, Am. Naturalist, 74, 1910, 117-128; Priode, Am. Jour. Bot , 15, 1928, 88-93, Stanley, Jour. Biol, Chem. 129, 1939, 405-428, 429-436. Stanley and Wyckoff, Science, 85, 1937, 181-183, Valleau, Kentucky Agr Exp. Sta , Bull, 327, 1932; Wingard, Jour, Agr. Res., 37, 1928, 127-153; Woods, Contrib. Boyce Thompson Inst , 5, 1933, 419-431.

Strains A number of distinctive strains have been collected in nature and studied experimentally. The following have been given varietal names to distinguish them from the type, var. rirginerais II., loc. cit., 98:

Ia. Annulus tabaca var. Lentuckrenas II. (for. et., 993). Differing from the typical strain in producing less necrosis and less stunting in tolacco. (Price, Phytopath., 26, 1936, 665-675; Valleau, Kentucky Agr. Pep. Sta., Bull. 327, 1632.)

1b. Annulus tabaci var. auratus II. (loc. cit., 100). Secondary lesions in

tobacco at first yellow spots or rings, becoming necroic subsequently. Recovery less complete than with type, abnormal yellowing of old leaves tending to persist. (Chester, Phytopath., 28, 1936, 686-701, Price, Phytopath., 28, 1936, 656-765, Valleau, Kentucky Agr. Eyp. Sta., Bull 327, 1932, Phytopath., 29, 1939, 549-551.

Annulus zonatus II. (loc. cit., 101).
 From Latin zonatus, zonate.

Common names Tomato-ringspot virus, ring spot No. 2 virus.

Hosts SOLANACEAE—Nicotiana tabacum L, tobacco. Experimentally this virus has been found to infect many species of plants in a large number of families.

Geographical distribution: United States.

Induced disease. In tobacco, zonate necrotic primary lesions and, temporarily, secondary lesions of the same type; recovery with specific, non-sterile immunity. In tomato, systemic infection, yellowish-green or necrotic ring-like lesions, stunting.

Transmission. By moculation of ex-

Immunological relationships: Recovered plants are immune to reinfection but are still susceptible to Annulus labaci, A. bergerae, and several mosaic-type viruses that have been tested.

Thermal inactivation At 55 to 60° C in 10 minutes

Filterability Passes Gradocol membrane 100 millimicrons in average pore diameter. Particle size estimated as 50 millimicrons or less.

Literature Price, Phytopath., 25, 1936 665-675, Am. Jour. Bot., 27, 1940, 530-541.

3 Annulus orae H. (Holmes, loc. etc., 103, Tractus orae Valleau, Phytopath., 50, 1940, 826.) From Latin ora, edge, in reference to occurrence of induced discuss near odes of tubacco fields.

Common name: Tolacco-streak virus, Hosts. SOLA VACEAE-Nicolana tolacum L., tolacco. Experimentally, a number of other solanaceous plants have been reported as susceptible, but not Copsicum fruitscens L., pepper; Lycopersicon esculentum Mill., tomato; Solanum milongena L., eggplant; or S. tuberosum L., potato.

Geographical distribution: United

Induced disease In tobacco, local and systemic necrosis in 3 days, with irregular spot, line, and ring-like lesions, followed by recovery from necrotic manifestations of disease. Recovered leaves may show a mild mottling and regularly contain virus; reinoculation does not induce formation of necrotic lesions in them.

Transmission: By inoculation of expressed juice. Not through seeds from diseased plants.

Immunological relationships No crossprotection with respect to A. tabaci, and several viruses of the mosaic group.

Thermal mactivation: At 53° C in 10 minutes.

Literature Johnson, Phytopath., 26, 1936, 285-292; Trans. Wisconsin Acad. Sciences, Arts and Letters, 50, 1937, 27-34.

4. Annulus apertus spec. nov. From Latin apertus, frank.

Common name: Broad-ringspot virus. Hosts: SOLANACEAE—Nicotiana tabacum L., tobacco. Experimentally also to many species in this and other families.

Insusceptible species: CHENOPODI-ACEAE—Beta vulgaris L. CUCURBI-TACEAE—Citrullus vulgaris Schrad. LEGUMI NOSAE—Medicago sativa L., Melilotus alba Desr.

Gecgraphical distribution: United States (Wisconsin).

Induced disease In tobacco, indistinct yellow-spot primary lesions, becoming chlorotte or necrotic rings with concentric markings; small chlorotte rings, sometimes concentric, or fine brown erotic rings as secondary lesions; young leaves puckered at first, somewhat malformed.

Transmission: By inoculation of expressed juice.

Immunological relationships: Protects against reinfection with homologous virus but leaves host susceptible to infection by Annulus tabaci, A. zonatus, and some mosaic-type viruses.

Literature: Johnson and Fulton, Phytopath., S2, 1942, 605-612.

5. Annulus dubius (Holmes) comb.nov. (Marmor dubium H., loc. cit., 42.) From Latin dubius, uncertain, in reference to a common name, potato virus X, often used to designate this virus.

Common name: Potato-mottle virus (strains of this virus have been studied at various times under the names potato latent virus, potato virus X, potato-anecrosis virus, virulent latent virus, simple mesaic virus, healthy potato virus, Hyoscyamus IV virus, President streak virus, potato foliar-necrosis virus, potato foliar-necrosis virus, potato foliar-necrosis virus, potato streak virus, Up-40-Date streak virus, potato viruses B and D, Solanum viruses 1.4 and E.

Hostes: SOLANACEAE—Solanum tuberosum L., potato; Lycopersienn estulatum Mill, Lomato. Experimentally, alos
SOLANACEAE—Capsicum fruteras
L., pepper; Datura stramonium L., Jimson weed; Hyaosepamus niger L., henhane;
Nicotuana tabacum L., tohacco; Physlis
alkekeng; L.; Solanum dulcamara L, bittersweet; S. nigrum L., black nightstade.
AMARANTHACEAE—Amaranhus
retroflezus L. COMPOSITAE—Chrysathemum mortfolium Ram. SCROPHILARIACEAE—Veronica sp., common
speedwell.

Geographical detribution: Widespread throughout the world; present in all known stocks of tubers of some potato varieties in the United States.

Induced discove: In potato, usually no chlorotic mottling, sometimes a little; intracellular inclusions of the vacuolated, granular type; some varieties that are virtually immane in the field one their tendency to localize the virus in necrotic primary lesions or in top-necrosis of far systemically infected plants to a dom-

fragaroidea came from butter; it liquefies gelatin, coagulates milk, and grows at 37°C.

\*23. Pseudomonas nebulosa (Wright) Chester. (Bacillus nebulosus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 465; Chester, Man. Determ. Bact., 1901, 311, Achromobacter nebulosum Bergey et al., Manual, 1st ed., 1923, 145; not Bacillus nebulosus Hallé, Thèse de Paris, 1893; not Bacillus nebulosus Wincent, Ann. Inst. Past., 21, 1907, 69; not Bacillus nebulosus Migula, Syst. d. Bakt., 2, 1900, 544; not Bacillus nebulosus Goresine, Jour. Bact., 27, 1934, 52.) From Latin, nebulo, mist.

Medium-sized rods, occurring singly Motile, possessing polar flagella. Gramnegative.

Gelatin colonies: Thin, circular, gray, translucent, hazy, with white center

Gelatin stab: Crateriform liquefaction Agar slant: Thin, transparent streak. Broth: Turbid, with gray sediment. Litmus milk: Alkaline; reduction of

litmus. Potato: Scanty growth.

Indole not formed.

Nitrates not produced from nitrates.

Sugar gelatin in deep stab. Fair growth, with some gas formation.

Aerobic, facultative.

Optimum temperature 30° to 35°C

Habitat: Water.

Probable synonym: Pseudomonas cen-

trifugans Chester. (Man. Determ Bact., 1901, 312; Bacillus centrifugans Wright, Mem. Nat. Acad. Sci., 7, 1895, 462.)

34. Pseudomonas coadunata (Wright) Chester. (Bacillus coadunatus Wright, Memoirs Nat. Acad. Sci., 7, 1893, 469) Chester, Man. Determ. Bact., 1901, 310; Achromobacter coadunatum Bergey et al., Manual, 1923, 147.) 1st ed., From Latin, coadunatus, to unite closely. Medium-sized rods, with rounded ends, occurring singly, in pairs and in chains. Mottle, possessing a polar flagellum. Gram-negative.

Gelatin colonies: Circular, brownish, dense.

Gelatin stab: Crateriform to stratiform liquefaction.

Agar slant: Gray, translucent,

Broth: Turbid, with gray pellicle and sediment. The medium has a slight greenish tint.

Litmus milk: Acid; coagulated. Indole is formed.

Nitrites not produced from nitrates.

Sugar gelatin in deep stab: Good growth of discreet and confluent whitish colonies. Marked gas production; no liquefaction. Aerobic, facultative.

Optimum temperature 20° to 25°C. Habitat: Water.

35 Pseudomonas multistriata (Wright) Chester. (Bacilus multistriatus Wright, Memoirs, Nat. Acad. Sci., 7, 1895, 462; Chester, Man Determ. Bact, 1901, 310; Achromobacter multistriatum Bergey et al, Manual, lat ed, 1923, 147) From Latin, multus, many, much; stratus, grooved.

Medium-sized rods, with rounded ends, occurring singly and in pairs. Motile, possessing polar flagella. Gram-negative. Gelatin colonies: Circular, gravish-

white, translucent.
Gelatin stab Crateriform liquefaction.

Agar slant: Narrow, translucent, grayish streak.

Broth: Turbid.

Litmus milk: Slightly acid; coagulated. Potato. Grayish to creamy, thick, glustening, viscid, spreading.

Indole not formed.

Nitrites not produced from nitrates. Sugar gelatin in deep stab: Vigorous growth with marked gas production; also liquefaction.

<sup>\*</sup>Prof. E. R. Hitchner, Univ. of Maine, Orono, Maine assisted in rearranging the descriptions of the acid and gas producing pseudomonads (Aeromonas), April, 1913

anisotropy of flow. Destroyed by drying. Inactivated by papaine and cyanide, but by neither separately. Digested by 0 02 per cent solution of pepsin in 3 hours at pH 4, at 38° C. Digested also by trypsin. About 6 per cent of the purified views is reported to be a pentose nucleic acid, but the carbohydrate to phosphorus ratio is about twice that for yeast nucleic seid. Guanine and pentose present. Analysis of sedimented virus, carbon 47.7 to 49.5 per cent, hydrogen 6.8 to 7.7 per cent. nitrogen 14.6 to 17.0 per cent, phosphorus 0.4 to 0.7 per cent, sulfur 1.1 per cent. carbohydrate 2.5 to 4.3 per cent, ash 2.0 to 2.5 per cent. Reduction of carbohydrate content of sample to 2.5 per cent does not reduce activity of virus; further reduction mactivates. (Ainsworth, Ann. Appl. Biol., 21, 1934, 581-587. Bawden, Brit, Jour. Exp. Path., 16, 1935, 435-443; Bawden and Pirie, 1bid., 19, 1938, 66-82, Birkeland, Bot. Gaz., 95, 1934, 419-436; Chester, Phytopath., 26, 1936, 778-785; Johnson, Wisconsin Agr. Exp. Sta., Res. Bull. 76, 1927; Loring, Jour. Biol. Chem., 126, 1938, 455-478; Loring and Wyckoff, abid., 121, 1937, 225-230.)

5b. Annulus dubrus var. flavus H. (loc. ett., 46). From Latin flavus, yellow. Common name: Yellow-mottle strain of potato-mottle virus. Differing from the type by imparting a yellow cast to folige of infected potatoes. (Putnam, Canad. Jour. Res., Sec. C, 15, 1937, 87-107.)

5c. Annulus dubius var. obscurus H. (loc. ett., 46). From Latin obscurus, obscure. Common name. Masked-mottle strain of potato-mottle virus. Differing from the type by systemically infecting potato, tobacco, and Jimson weed without symptoms under ordinary experimental conditions; in pepper, however, systemic necrosis is induced, as by all known straint. (Chester, Phytopath., 26, 1936, 778-785.)

 Annulus delphinii spec. nov. From New Latin Delphinium, generic name of host.

Common names: Delphinium-ringspot virus, perennial-delphinium ringspot virus.

Hosts: RANUNCULACEAE—Delphinium sp., perennial delphiniums.
Experimentally, also to CHENOPODIACEAE—Beta vulgaris L. CUCURBITACEAE—Cucumis sativus L. cucumber. MALVACEAE—Gassypium
hirsutum L. RANUNCULACEAE—
Ranunculus assaticus L. (symptomless
carrier). SOLANACEAE—Datura
stramonium L., Nicotiana alata Link and
Otto, N. glutinosa L., N. rustica L., N.
tabacum L., Petunia hubrida Vilim.

Geographical distribution: United States (California).

Induced disease: In perennial delphiniums, faint chlorotic rings with green or yellow centers on young leaves, irregular chlorotic spots, yellow bands, or irregular chlorotic rings on mature leaves.

Transmission: By inoculation of expressed juice in the presence of finely powdered carborundum.

Thermal inactivation: At 65° C in 10 minutes,

Literature · Severin and Dickson, Hilgardia, 14, 1942, 465-490.

7. Annulus bergerac H. (loc. cit., 102).
From Bergerac, a town in southwest
France.

Common name, Bergerac-ringspot

Hosts: SOLANACEAE—Nicoliana labacum L., tobacco. Experimentally, this wirus has been transferred to several other solanaceous plants and to Phascolus vulgarus L., bean, in the family LEGUM-INOSAE.

Geographical distribution: France.
Induced disease: In tobacco, thin
necrotic-ring primary lesions, followed by

inant allele of a gene nz, which characterizes plants showing a mosaic of some degree of intensity on infection with this virus: the variety known as \$41956 is immune to all tested strains of the virus and possesses two dominant genes both required for resistance. In tomato, systemic mild chlorotic mottling; if a strain of tobacco-mosaic virus is also present, a severe systemic necrosis, known as double-virus streak, is induced.

Transmission: By inoculation of expressed juice. Experimentally, by leaf contacts mainly under the influence of wind. No insect vector is known. Not transmitted through true seeds of the potato.

Serological relationships; Cross precipitin reactions between constituent strains of this virus. No cross reaction with potato aucuba-mosaic, potato mild-mosaic, potato-veinbanding, tobacco-mogaic, tobacco-etch, tobacco-ringspot or pen mosaic virus. Antisera prepared by injecting rabbits intravenously with virus inactivated by nitrous acid, like those prepared with active virus, fix complement and flocculate with virus suspensions (though not with juice of healthy host plants), they are also effective in neutralizing the virus.

Immunological relationships · Tobacco and Datura plants infected by the type strain of this virus become immune to the more severe potato-ringspot strain. No protection against the severe strum is afforded by previous infection with tolacco-mosaic, tobacco-ringspot, tomato spotted-wilt, or cucumber-mosaic virus. Thermal mactivation - At 70° C in 10

minutes Passes Pasteur-Cham-Filterability

berland L. L. and L. filters. Other properties: Digested by 0 02 per

cent solution of pepsin in 3 hours at pH 4, at 35° C Digested also by trypsin, Inactivated by papaine and eyanide, but by neither separately. Isoelectric point near pH4. Dilute solutions show anisotropy of flow Concentrated solutions are spontaneously birefringent. Propertice of the type strain have been less studied than those of the potato-ringanot strain of this virus.

Literature: Bawden, Proc. Roy. Soc. London, Ser. B. 116, 1934, 375-395; Bawden and Pirie, Brit, Jour, Exp. Path., 17, 1936, 64-74; Bawden et al., sbid., 17, 1936. 201-207; Blodgett, Phytopath., 17, 1927. 775-782. Böhme, Phytopath. Ztschr., 6, 1933, 517-524, Cadman, Jour. Genetics, 44, 1942, 33-52; Chester, Phytopath., 27, 1937, 903-912; Clinch, Sci. Proc. Roy. Dublin Soc., 23, 1942, 18-31; Johnson, Wisconsin Agr. Exp. Sta., Res. Bull. 63, 1925. Koch, Phytopath . 25, 1933, 319-342, Köhler, Phytopath. Ztschr., 5, 1933, 567-591; 7. 1934, 1-30; Loughnane and Murphy, Nature, 141, 1938, 120; van der Meer, Cent. f. Bakt., II Abt., 87, 1932. 210-262; Salaman, Nature, 131, 1933, 463; Schultz et al., Phytopath., 27, 1937, 190-197; 30, 1910, 911 951, Spooner and Bawden, Brit. Jour Exp. Path., 16, 1935, 218-230, Stevenson et al., Phytopath., 29, 1939, 362-365,

Strains: Several variants of potatomottle virus, differing from the type, var. rulgaris II. (loc. cit., 42), have been recognized as distinctive varieties under the following names:

5a. Annulus dubius var. annulus II. (loc. cit., 41). From Latin annulus, ring.

Common name: Ringspot strain of potato-mottle virus. Necrotic primary and secondary ring-like lesions in experimentally infected tobacco plants. Indistinguishable from type strain by ordinary precipitin test, but distinguishable when appropriately absorbed sera are used. This strain has been more frequently studied than the type. Juice of infected tobacco plants contains about 0.02 to 0.10 mg of virus per ml. Sedimentation constants, Su\* = 113 × 10-13 and 131 × 10-12 cm. sec. 1 dyne-1. Dissymmetry constant 2.78. Molecular weight 26 X 104. Particle size estimated to be 433 by 9.5 millimicrons, 43.9 times as long as wide. Isoelectric point near pH 4, Stable between pH 4 and pH 9.5. Concentrate l solutions are apontaneously birefringent. Dilute solutions

# FAMILY IV. RUGACEAE HOLMES.

(Handb. Phytopath. Viruses, 1939, 114)

Viruses of the Leaf-Curl Group, causing diseases characterized by auddenly arrested development of invaded tissues, resulting in leaf curl, enations, and other deformities. Vectors, typically white-flies (ALEYRODIDAE). There is a single genus.

## Genus I. Ruga Holmes.

(Loc. cit., 114.)

Characters those of the family. Generic name from Latin ruga, a wrinkle. The type species is Ruga tabaci Holmes.

## Key to the species of genus Ruga,

- I. Infecting tobacco.
- II. Infecting cotton.
- III. Infecting cassava (Manihot).
- IV. Infecting sugar-beet.
- Ruga tabaci Holmes. (Handb. Phytopath. Viruses, 1939, 115.) From New Latin Tabacum, former generic name of tobacco.

Common names Tobacco leaf-curl virus, kroepoek virus, curl-disease virus, crinkle-disease virus.

Hosts: SOLANACEAE—Necotiona tabacum L., tobacco. COMPOSITAE— Vernonia volocalyz, V. cineria, Ageratum conyzoides L., Synedrella nodiflora Gaertn. Experimentally, also other solanaceous plants.

Insusceptible species · MALVACEAE

-Gossprium hirsulum L, cotton.

Geographical distribution: Tanganyika, Southern Rhodesia, Southern Nigeria, Nyasaland, India, Sumatra, Formosa.

Induced disease: In tobacco, leaves curled and crunkled, with occasional leafy outgrowths or enations. Veins greened and thickened. No chlorosis nor necrosis. Plant stunted.

Transmission. By white-fly, Bemisia gossypiperda Misra and Lamba (ALEY-RODIDAE). By grafting. Not by inoculation of expressed fuice.

Literature: Kerling, Phytopath., 25, 1933, 175-190; Mathur, Indian Jour. Agr.

- 1. Ruga tabaci.
  - 2. Ruga gossupii.
  - 3. Ruga bemisiae.
  - 4. Ruga verrucosans.

Sci., 5, 1933, 89-96; Matsumoto and Tateolo, Trans, Nat, Hist, Soc. Formess, 50, 1940, 31-33; Pal and Tandon, Indian Jour, Agr. Sci., 7, 1937, 363-393; Pruthi and Samuel, tbid, 7, 1937, 659-670; Storey, Nature, 128, 1931, 187-188; East African Agr. Jour., 1, 1935, 148-153; Thung, Meded. Proefsta, Vorsteal, Tabak Java, 72, 1932, 78, 1934.

2. Ruga gossypil H. (loc. cit., 116). From Latin gossypium, cotton,

Common names: Cotton leaf-curl virus, cotton leaf-crinkle virus.

Hosts: MALVACEAE-Gossypium

Althaea rosea Cav., hollyhock; Saket

(hybrid) cotton.

Geographical distribution: The Sudan and Nigeria, in Africa.

Induced disease: In cotton, clearing of veins, blistering and pale spotting of leaves; leaves puckered at edge and unsymmetrical. Internodes shortened, producing bunchy growth.

Transmission: By white-fly, Bemisia gossypiperda Misra and Lamba (ALEY-

systemic mottling with some chlorotic rings on the dark green islands. Later, complete recovery occurs, with nonsterile immunity.

Transmission: By moculation of expressed juice.

Immunological relationships: Recov-

ered plants are susceptible to infection by Annulus tabaci and A. zonatus.

Thermal inactivation: At 80° C in 10 minutes.

Literature: Smith, A textbook of plant virus diseases, P. Blakiston's Son and Co., Inc., Philadelphia, 1937, 285-289.

the end of the season, showing puckering and downward curling of leaves at the top of the plant, reduction in size of new leaves, and shortened internodes, or they may gradually become chlorotic and die-

Transmission: By leafhopper, Eutettix tenellus (Baker) (CICADELLIDAE) with 4 to 12 hour preinfective period. Through dodder, Cuscuta campestrix Yuncker (CONVOLVULACEAE). Not, with any regularity at least, by mechanical inoculation of expressed juice. Not through seeds of diseased plants to seed-lines germinating from them. The leafhopper, Agalliana ensigera Oman (CICADELLIDAE), is said to transmit a South American strain of sugar-beet curly-top virus, but evidence for identity of the virus has not yet been reported in detail.

Thermal inactivation At 75° to 80° C in 10 minutes.

Filternbility: Passes Berkefeld V, N, and W, Mandler medium and fine, and Chamberland In, Lu, In, In, In, In, In and Ins filters.

Other properties: Withstands alcohol and acetone treatments. A pH of 2.0 rol rower inactivates, but an alkaline reaction as high as pH 9.1 does not inactivate, in 2 hours. Virus active after at least 8 vers in trasues of thoroughly dried young

sugar-beet plants, 6 months in dried leafhoppers, and 10 months in dried phloem exudate.

Strains: In general it has proved possible to modify strains by host passage, some hosts like Chenopodium murale L. appearing to select less virulent strains, others like Stellaria media (L.) Cyr. reversing this selection and restoring virulence.

Literature: Bennett, Jour. Agr. Res., 48, 1934, 665-701; 50, 1935, 211-241; 56, 1938, 31-52; Phytopath., 32, 1942, 826-827: Carsner, Phytopath., 15, 1925, 745-757; U. S. Dent. Agr., Tech. Bull. 360. 1933; Jour. Agr. Res., 83, 1926, 345-318; Dana, Phytopath., 28, 1938, 649-656; Fawcett, Revista Industrial v Agricola de Tucumán, 16, 1925, 39-46; Fife, Phytopath., 30, 1940, 433-437; Giddings, Phytopath., 27, 1937, 773-779; Jour. Agr. Res., 56, 1938, 883-801; Lackey, Jour. Agr. Res., 55, 1937. 453-160: Lesley and Wallace, Phytopath., 28, 1938, 548-553; Murphy, 161d., 50, 1940, 779-781; Severin, Hilgardia, 3, 1929, 595-636; Severin and Freitag, 1bid., 8, 1933, 1-48, Severin and Henderson, Hilgardia, S. 1928, 339-393; Severin and Swezy, Phytopath., 18, 1928, 681-690; Shaw, U. S. Dept. Agr., Bull. 181, 1910.

RODIDAE). Not through egg of insect vector. Not by inoculation of expressed juice. Not through soil. Not through seeds from diseased plants.

Literature: Bailey, Empire Cotton Growing Rev., 11, 1934, 280; Kirkpatrick, Bull. Entom. Res., 21, 1930, 127-137; 23,

1931, 323-363.

3. Ruga bemisiae II. (Holmes, loc. ett., 117; Ochrosticta bemisiae McKinney, Jour. Washington Acad. Sci., 54, 1914, 149.) From New Latin Bemisia, generic name of insect vector.

Common names: Cassava-mosaic virus,

Hosts: EUPHORBIACEAE-Manihot utilissima Pohl, cassava; M. palmata

Muell., M. duteis.

Geographical distribution: Gold Coast,
Belgian Congo, French Cameroons, Rhodesia, Liberia, Madagascar, probably
havebout Miles and advant, islands.

throughout Africa and adjacent islands; Java. Induced disease: In Manihot utilissima, leaves unsymmetrical, curled, distorted,

leases unsymmetrical, curled, distorted, mottled, internodes shortened, plants stunted. Axillary buds produce an extra number of side branches.

Transmission. By white-flies (ALEV-RODIDAE), Bemissa nigeriensis Corb., in Southern Nigeria, and B. gosspyrjerda Misra and Lamba, in Belgian Congo and Tanganyika. White-flies infect only young leaves. Not by needle-puncture, rubbing, or hypodermic-needle injection of turce corresed from diseased plants.

Interature Dade, Yearbk, Dept, Agr Gold Ceast, 1909, 245; Duffenoy and Hedin, Rev. Bot. Appl., 9, 1929, 361-365; Golding, Trop. Agric., Trinidad, 15, 1930, 182-188, Kulferath and Gheaquière, Compt. tend. Soc. Biol. Belge, 109, 1932, 1140, Lelevre, Bull. Agr. Conpo Belge, 26, 1975, 442, McKinney, Jour. Agr. Res., 37, 1929, 557-378; Muller, Bull. Inst. Plantenickt., 24, 1931, 1-17; Pascalet, Agron Colon, 24, 1932, 117, Staner, Bull. Agr. Congo Belge, £f. 1931, 75; Storey, East Afr. Jour. 2, 1976, 24-27; Storey and Nichols, Ann. Appl. Biol., £5, 1938, 790-809; Zimmermann, Pflanere, £, 1906, 143. 4. Ruga verrucosans Carsner and Bennett. (Chlorogenus suteiticola (in error for eutetligicola, from New Latin Eutettiz, genus name of a vector, and Latin -cola, dweller in er inhabitant of) Holmes. 1939, loc. cit., 11; Carsner and Bennett, Science 98, 1913, 386.) From Latin, meaning: causing rough swellings.

Common name: Sugar-beet curly-top

Hosts. Very wide range in many families of dicotyledonous plants. Among the horticulturally important host plants are the sugar beet (Reta vulgaris L., CHENOPODIACEAE); bean (Phasedus vulgaris L., LEGUMINOSAE); squash (Cucurbita species, CUCURBITACEAE); and tomato (Lycopersion esculentum Mill., SOLAN MCGAE).

Geographical distribution: Western North America; in Argentina a strain of virus thought to belong here has been reported but has not yet been fully described.

Induced disease: In beet, clearing of veins, leaf eurling, sharp protuberances from veins on loner surface of leaves. increase in number of rootlets, phloem degeneration followed by formation of supernumerary sieve tubes, retardation of growth. In tomato, fnestern vellow blight or tomato yellows), phloem degeneration followed by formation of supernumerary sieve tubes, retardation of growth, dropping of flowers and buds, rolling, vellowing and thickening of leaves. root decay, usually followed by death, sometimes by recovery, Occasionally there is relapse after recovery. In cucurbitaceous plants, stunting, bending unward of tip of runner, yellowing of old leaves, abnormally deep green in tip leaves and stem; Marblehead squash is tolerant, showing only mild witches' broom formation and phyllody. In bean, infected when young, thickening and downward curling of first trifoliate leaf. which becomes brittle and will break easily from the stem; leaves become chloratic plant stone mon '--- ! . "

Transmission: By inoculation of expressed juice. By the tarnished plant bug, Lygus pratensieLinn. (MIRIDAE). The insect vector retains this virus during intervals between crops.

Literature: Kaufmann, Arb. Biol. Reichsanst. Land- u. Forstw., 21, 1936, 605-623; Mitteil. Landwirtsch., 37, 1936; Pape, Deutsch. Landwirtsch. Presse, 26, 1935.

#### FAMILY V. SAVOIACEAE HOLMES

(Handb Phytopath. Viruses, 1939, 131.)

Viruses of the Savoy-Disease Group, causing diseases characterized mainly by crinkling of foliage. Vectors, true bugs (PIESMIDAE and MIRIDAE). There is a samele genus.

#### Genus I. Savoia Holmes.

(Loc. cit., 131.)

Characters those of the family. Generic name from French chou de Savoie, cabbage of Savoy, a cabbage with wrinkled and curled leaves.

The type species is Saroia betae Holmes.

Key to the species of genus Savola.

I Infecting beet.

- Savoia betae.
- 2. Saroia presmae.
- Infecting rape and rutabaga.
- 3. Saroia napi.

1 Savota betae Holmes. (Handb Phytopath Viruses, 1939, 132) From Latin beta, beet. Common names: Beet-Kräuselkrank-

beit virus, sugar-beet leaf-curl virus, sugar-beet leaf-curl virus, Kopfsalat virus.

Host CHENOPODIACEAE—Beta tulgaris L., beet.

Geographical distribution Germany, Poland

Induced disease: In beet, tenns of leaves swollen, retarded in growth, causing crinkling. New leaves remain small and incurved, forming a compact head. Old leaves die, plant succumbs before harvest time. Prepatent period in plant, 310 9 weeks.

Transmission. By tingid bug, Piesma quadrata Vieb. (PIESMIDAD). Not by inoculation of expressed juice.
Literature Wille, Arb. Biol. Reich-

Literature Wille, Arb. Biol. Reichsan-t. Land-u. Forstw., 16, 1928, 115-167.

 Savoia piesmae H. (loc. cit., 132)
 From New Latin Piesma, generic name of insect vector.

Common name Beet savoy virus.

Host CHENOPODIACEAE—Beta
endgaris L., beet

Geographical distribution United States (Michigan, Ohio, Minnesota, Nebraska, South Dakota, Colorado, Wyoming) and Canada.

Induced disease: In beet, leaves dwarfed, curled down, small veins thickened. Phloem necrosis in roots. Prodromal period in plant. 3 to 4 weeks.

Transmission. By tingid bug, Piesma einerea (PIESMIDAE). Not by inoculation of expressed juice.

Literature Coons et al., Phytopath., 27, 1937, 125 (Abst.); Hildebrand and Koch, 151d., 32, 1942, 328-331.

Savoia napl II. (loc. cit., 133).
 From New Latin Napus, former generic name of rape, Brassica napus I.

Common name Rape-savoy virus.
Hosts: CRUCIFERAE-Brassica na-

Hosts: CRUCIFERAE—Brassica napus L., rape, B. napobrassica Mill., rutaloga

Geographical distribution: Germany, Induced disease. In rape, twisting and crinkling of young leaves; premature death of old leaves and of plants; in surviving plunts, inhibition of growth in spring. In rutalego, mottling and erinkling of leaves, with formation of fissures at leaf edges. Plants rarely killed.

infective thrips. Probably not through seeds of infected plants. Not through soil.

Immunological relationships: Infects tobacco plants previously infected with tobacco-mosaic, potato-mottle, tobaccoringspot, and tomato-ringspot viruses.

Thermal inactivation: At 42° C in 10 minutes.

Filterability Passes Gradocol membrane of 0.45 micron pore diameter.

Other properties: Virus readily inactivated by desiccation or by action of oxidizing agents; activity prolonged by presence of sodium sulfite, cystein, or by low temperatures. Unstable at pH values below 6 and above 9.

Literature. Ainsworth et al., Ann. Appl. Biol., 21, 1934, 566-580; Andrewartha, Trans. Roy. Soc. of So. Australia, 61, 1937, 163-165, Bald and Samuel, ibid., 21, 1934, 179-190; Berkeley, Scientific Agr., 15, 1935, 387-392, Best, Austral. Chem. Inst. Jour. and Proc., 4, 1937, 375-392; Best and Samuel, Ann. Appl. Biol., 23, 1936, 509-537; 759-780, Carter, Phytopath., 29, 1939, 285-287; Lewcock, Queensland Agr. Jour , 48, 1937, 665-672; Linford, 1bid., 22, 1932, 301-324, Magee, Agr. Gaz. of New South Wales, 47, 1936, 99-100, 118, McWhorter and Milbrath, Phytopath., 25, 1935, 897-898 (Abst.), Oregon Agr. Exp. Sta , Circ. 128, 1938; Milbrath, Phytopath., 29, 1939, 156-168; Moore, Nature, 147, 1941, 480-481; Moore and Anderssen, Union of So. Africa, Dept. Agr., Science Bull. 182, 1939, Parris, Phytopath., 30, 1940, 299-312, Rawlins and Tompkins, ibid., 26, 1936, 578-587, Sakimura, ibid., 30, 1940, 281-299; Samuel and Bald, Ann. Appl. Biol., 20, 1933, 70-99; Jour. Agr. So. Australia, 37, 1933,

190-195; Samuel et al., Counc. Scient, Indus. Res., Austral., Bull. 44, 1930, Ann. Appl. Biol., 22, 1935, 508-524, Shapovalov, Phytopath., 24, 1931, 1140 (Abst.); Smith, Nature, 127, 1931, 825-853; Ann. Appl. Biol., 19, 1932, 305-309, Jour. Minist. Agr., 32, 1933, 1097-1101; Jour. Roy. Hort. Soc., 60, 1935, 301-310; Snyder and Thomas, Hilgardia, 10, 1936, 257-262; Takahashi and Rawlins, Phytopath., 24, 1934, 1111-1116; Taylor and Chamberlain, New Zealand Jour. Agr., 43, 1937, 278-283; Whipple, Phytopath., 28, 1936, 918-920.

Strains: A strain differing somewhat from the type, var. typicum H. (loc. cit.) 130), has been described as damaging tomatoes in the northwestern United States. It has been given a distinctive varietal name:

 Lethum australiense var. Icthale II. (loc. cit., 138). From Latin lethalis, deadly. Common names: Tip-blight strain of tomato spotted-wilt virus, Oregon tip-blight virus, tomato die-back streak virus, tomato tip-blight virus. Differs from the type in causing necrotic leaf spotting, stem streaking, and tip blighting in most hosts, without mottling or bronzing of foliage; yet in Tropacolum majus L., there is little necrosis. In tomato, systemic necrosis, terminal shoots blighted and blackened; dead tips stand upright above living foliage. Fruits rough and pitted, with internal pockets of necrotic tissue or with subepidermal necrosis, appearing externally as concentric brown bands. (McWhorier and Milbrath, Oregon Agr. Exp. Sta. Circ. 128, 1938; Milbrath, Phytopath., 29, 1939, 156-168.)

## FAMILY VI. LETHACEAE HOLMES.

(Handb. Phytopath. Viruses, 1939, 135.)

Virus strains of the Spotted-Wilt Group, causing diseases characterized by bronzing of tolage, streaking of stems, blighting of tips, necrotic spotting of foliage. Hosts, higher plants; vectors, thrips (THRIPIDAE). There is a single genus.

### Genus I. Lethum Holmes.

(Loc. cit., 135.)

Characters those of the family. Genetic name from Latin lethum, death. At present there is but one known species, though this is reported to be nearly world-wide in distribution. In some areas it may have been confused with entities needing separate recognition.

The type species is Lethum australiense Holmes.

1. Lethum australiense Holmes (loc. cit., 136). From Australia, where virus was first described.

Common names: Tomato spotted-wift virus, kromnek or Kat River disease virus. Also, pineapple yellow-spot or side-rot virus (according to Sakimura, Phytopath. 50, 1940, 281-299).

Hosts. Very numerous species in many families of higher plants. Among those most often noted are. SOLANACRAE—Lycopersteon exculentum Mill., tomato; Nicotiana dabosem L., tobacco; Solamu tuberosium L., potato. COMPOSITAE—Lactuce satina L., lettuce. LEGUM-INOSAE—Pisum sativum L., potato, Mort., putacopile. Merr., putacopile.

Geographical distribution: Australia, British Ieles, United States, South Africa Hawaii, New Zealand, Europe, China, South America.

Induced disease: In tomato, bronze rung, the secondary lesions, plant stunted, some necrosis; later yellowish mosaie with some leaf distortion. Fruit frequently marked with concentre rings of pide red, yellow, or white. In tobacco, primary necrotic lesions followed by systemic necrosis, with stem streat, crooknets, often stunting with subsequent willing and death, sometimes temporary rerovery followed by recurrence of systemic necrosis. In lettuce, plant yellowed, retarded in prowth prowa blem.

ishes in central leaves, affected spots dying, becoming like parchment but with brown margins. Axillary shoots may show chlorotic mottling. In pea, purplish necrotic streaks on stem, at first, leaves mottled; later, necrotic spots damage foliage; pods show circular necrotic spots or wavy lines, or, if severely affected, may collapse; seeds may show necrotic lesions. In notato, zonate neerotic spots on upper leaves, necrotic streaks on stems; stems collapse at ton: plant is stunted, yield of tubers small. In pineapple, at first an initial spot or primary lesion i to i inch in diameter. raised, vellowish, on upper surface of young leaf; later chlorotic spotting of young leaves, crook-neck because of necrotic foci in stems and fruits (side rot); plant may die.

Transmission: By inoculation of expressed juice; the addition of fine carborundum powder to inoculum facilitates transmission by rubbing methods. By thrips, Franklinitla lycoperaci Andrewartia (formerly identited as F. maularis Franklin), F. occidentalis Pegg., F. monitoni Hood, and F. schultest (Trybon) (THRIPTDAE). Also by Thrips tober, Lind. (THRIPTDAE). In F. Lycoperaci, thrips must pick up virus while still a nymph; virus persists through puputon and emergence as adulty preinfective period in vector, 5 to 9 drys. Virus is not transactified through eggs of transactified through eggs of transactified through eggs of transactified through eggs of Virus is not transactified through eggs of transactified through eggs of transactified transact

Aerobic, facultative. Optimum temperature 20° to 25°C. Habitat : Water

36 Pseudomonas punctata (Zimmermann) Chester, (Bacillus punciatus Zimmermann, Bakt, unserer Trink- und Nutzwässer, Chemnitz, 1, 1890. 3S: Bacillus aquatilis communis Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 315; Bacterium punctatum Lehmann and Neumann, Bakt, Diag., 1 Aufl., 2, 1896, 238; Chester, Man. Determ. Bact., 1901, 313: Achromobacter punctatum Bergev et al., Manual, 1st ed., 1923, 147.) From Jatin, punctus, a puncture, point; M. L. punctate, dotted.

Rods: 07 by 1 0 to 1.5 micron, occurring singly, in pairs and in chains. Motile with a single polar flagellum. Gramnegative.

Gelatin colonies: Small, circular, gray, erose to filamentous, punctiform.

Gelatin stab: Crateriform liquefaction. No pellicle.

Agar slant: Grav, smooth, filamentous. Broth: Turbid with delicate pellicle. Litmus milk. Acid; coagulated; peptonized.

Potato: Brownish-vellow to brownishred color.

Indole is formed. Nitrites not produced from nitrates. Hydrogen sulfide is formed. Acid and gas from glucose.

philus Chester, Manual Determ, Bact., 1901, 235; Bacterium hydrophilum Weldin and Levine, Bact. Abs., 7, 1923, 14; Proleus hydrophilus Bergey et al., Manual, 1st ed., 1923, 211; Aeromonas hudrophila Stanier, Jour. Bact., 46, 1943, 213 ) From Greek, hydor, water, philus, loving: M. L. water-loving.

It was reported by Russell, Jour, Amer. Med. Assoc., 39, 1898, 1442 and later by Emerson and Norris, Jour. Exper. Med., 7, 1905, 32 who made a complete study of its properties and its pathogenic action. Weldin (Iowa State College Jour. Sci., 1, 1927, 151) considers Bacillus ranicida Ernst (Beitrage z. nath. Anst. u. z. Allgemein, Pathol., 8, 1890, 201; Bacterium ranicida Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 141) a possible synonym of Proteus hydrophilus.

Rods: 0.6 by 1.3 microus, occurring singly and in chains. Motile, with a single polar flagellum (Kulp and Borden, Jour. of Bact., 44, 1942, 673). Gramnegative.

Gelatin colonies: Small, circular, gray,

translucent, stippled.

Gelatin stab: Napiform liquefaction. Agar colonies: Whitish, raised, mosst, stimpled.

Agar slant: Thin, whitish, glassy,

spreading, becoming yellowish. Broth Turbid, with heavy pellicle. Litmus milk: Acid; coagulated; peptonized.

#### SUBORDER III. Zoophagineae subordo novus.

From Greek phagein, to eat, and zoon, an animal. Viruses infecting animals but having no plant hosts, so far as known.

#### Key to the families of suborder Zoophaginae.

- 1 Inducing diseases in insects as exclusive hosts.
- Family I. Borrelinaceae, p. 1225.
- 2 Inducing diseases of the pox group
  - Family II. Borreliotaceae, p 1229.
- 4
  - Family IV. Charonaceae, p. 1265.
- 5 Inducing diseases of the infectious anemia group Family V Trifurgees, p. 1282
- 6. Inducing diseases of the mumps group
  - Family VI. Rabulaceae, p. 1284.

#### FAMILY I. BORRELINACEAE FAM. NOV.

Viruses causing polyhedral, witt, and other diseases in arthropods. The genus Borretina Paillot was originally spelled Borrellina by error; from Borrel, name of French scientist.

#### Key to the genera of family Borrelinaceae.

- I. Known only as attacking lepidopterous insects.
- Genus I. Borrelina, p. 1225.
- II. Known only as attacking the honey bee, a hymenopterous insect. Genus II. Morator, p. 1227.

### Genus I. Borrelina Paillot.

(Compt. rend. Acad. Sci , Paris, 182, 1926, 182.)

Viruses inducing polyhedral, wilt, and other diseases; hosts, Lepidoptera, so far as known.

The type species is Borrelina bombuers Parllot.

#### Key to the species of genus Borrelina.

- I Attacking silkworm.
- 1. Rorrelina bombycıs.
- II. Attacking nun moth.

  III. Attacking gynsy moth.
- 2. Borrelina efficiens.
- IV. Attacking cabbage worm.
- 3. Borrelina reprimens.
- 4. Borrelina brassicae.
- 5 Borrelina pieris.

1. Borrelina bombycis Paillot. (Compt. rend. Acad. Sci., Paris, 162, 1926, 182.) From Latin bombyz, silk-worm. (Note: Coccus-like bodies surrounded by non-staining substances, associated with the induced disease, received the provisional name Chlamy-dozon bombycis from Prowarek, Arch. f. Protistenhunde, 10, 1907, 363.)

Common names: Silkworm-jaundice virus, silkworm-grasserie virus, silkworm wilt virus, Gelbsucht virus, Fettsucht virus.

Host: BOMBYCIDAE-Bombyz mori (L.), silkworm.

Geographical distribution: Japan, Italy, France,

Induced disease: In silkworm, after prodromal period of 5 days or more, yellow spots on skin, polyhedral bodies in blood, inactivity, loss of appetite, irritability, weakening of body facilitating rupture from mechanical stress, eventual death.

Transmission. By feeding, Experimentally, also by injection.

Scrological relationships: Specific agglutination, precipitation, and complement fixation.

Thermal inactivation: At 60° C in 15 to 20 minutes in blood.

Filterability Passes Berkefeld N and V, Chamberland L., L., and L. filters.

Other properties: May survive at least 2 years in dry state. Stable between pH 5 and about pH 9. Sedimentation constant 17 S.

Literature: Aoki and Chigasaki, Cent. f. Bakt., I Abt., Orig., 86, 1921, 481–485; Glaser and Locaillade, Am. Jour. Hyg., 20, 1934, 451–464; Glaser and Stanley, Jour. Exp. Med., 77, 1913, 451–466; v. Prowacek, Cent. f. Bakt., I Abt., Orig., 67, 1912, 268–284, Suzuki, Bull. Imperial Kyoto Sericultural College, 1, 1929, 45–5, Trager, Jour. Exp. Med., 61, 1935, 501–513.

2. Borrelina efficiens spec. nov. From

Latin efficiens, effective, in reference to effectiveness of this virus in controlling nun-moth infestations.

Common names: Nun-moth disease virus, nun-moth wilt virus, Wipfelkrankheit virus.

Host: LYMANTRIIDAE-Lymantria monacha (L.), nun moth.

Geographical distribution: Europe.

Induced disease: Ineggs, larvae, pupes and occasionally adults of nun moth, polyhedral bodies in affected tissues, Blood of sick larvae turbid; later, blood cells few; content of body finally become a gray-brown, semifluid mass,

Transmission: By feeding.

Thermal inactivation: At 55 to 60° C in 5 to 10 minutes.

Filterability: Fails to pass Berkefeld and Chamberland filters.

Other properties: May remain viable at least 2 years in dry state.

Literature: Escherich and Miyajima, Naturwissens, Ztschr. f. Forst- v. Land-wirtschaft, 9, 1911, 381-402; Wachti and Kornauth, Mitth. a. d. forstl. Versuchswesen Österreichs, 16, 1893, 1-38; Wahsens Olderreichs, 16, 1893, 1-38; Wahl, Centralbl. Gesam. Forstw., 25, 1909, 16t-172; 212-215; 26, 1910, 377-397; 37, 1911, 247-268; 38, 1912, 355-376.

3. Borrelina reprimens spec. nov. From Latin reprimere, to restrain.

Common name: Gypsy-moth wilt virus. Host: LYMANTRIIDAE-Porthe-

tria dispar (L.), gypsy moth.

Geographical distribution: United
States.

Induced disease: In gypsy moth caterpillar, flaccidity, disintegration of tissues, eventual collapse as a watery sack. Death occurs in 13 to 29 (average 21) days after infection; caterpillar may remain attached to its support by prolegs; skin ruptures easily. Polyhedral bodies originate in nuclei of the tracheal matrix, hypodermal, fat, and blood cells.

Transmission: By feeding on contam-

insted foliage. Not through undamaged skin.

Filterability: Passes Berkefeld N. not Pasteur-Chamberland F. filter.

Literature: Chaoman and Glaser, Jour. Econ, Entomol., 8, 1915, 140-150; 9, 1916. 149-167; Glaser, Jour. Agr. Res., 4, 1915. 101-128; Science, 48, 1918, 301-302; Glaser and Chapman, Jour. Econ. Entomol., 6, 1913, 479-488

4. Borrelina brassicae Paillot. (Compt. rend. Acad. Sci., Paris, 182. 1926, 182.) From name of host, Pieris brassicae.

Common name: Cabbage-worm grasserie virus.

Host: PIERIDAE-Pieris brassicae (L.), cabbage worm.

Induced disease: In cabbage worm, nuclear or cytoplasmic inclusions; nu no of fat and hypodermal cells hypertropeles and soon disorganized. hind

Transmission: By feeding. Other properties. Described

microscopie in size, intracytop's sub-Appendix: Borrelina flache ininic.

mori L. No previous refered and R. Cause of gettine in the silknorm, Bombyz Genus 11. More of this species has been lound. Only one species at present, inducing the bee. Genetic name from Latin moralor, lo gen. nov.

Moralor actatulae spec. nos. I. Morator actatulae spec noc. I'rom Latin actatula, early period of life, in reference to attack on immature stages

of host, exclusively. Common name Honey bee sacbroad

virus. Host: APIDAE-Apis mellifera L., honey bee (immature stages only).

Insusceptible species LYMANTRII-DAE-Porthetria dispar (L.), gypsy moth.

Geographical distribution; United States.

Literature: Paillot, loc. cil.; Ann. Inst. Pasteur, 40, 1926, 314-452; L'infection chez les insectes. Immunité et symbiose, 535 pages, Trevoux, Patiesier, 1933.

5. Borrelina pieris Paillot. (Compt. rend. Acad Sci., Paris, 182, 1926, 182.) From New Latin Pro-

of pierids. e : Virus of nuclear disease Host: P11.

(L.), cabbo ERIDAE-Pieris brassicae Induce ke sorm.

d disease: In cabbage worm, body bef yellowish below, tears easily just Listore death; chromatin of nuclei in fat and blood cells condensed in irregular masses: evtoplasmic inclusions staining

faintly red in Giemsa preparations. Transmission: By feeding

Other properties: Described as intraevtoplasmie, less than 0.1 micron in diameter

Literature : Paillot, loc, col. : Ann, Inst. Pasteur, 40, 1926, 314-452; L'infection chez les insectes. Immunité et symbiose, 535 pages, Trevoux, Patissier, 1933. 535 pp., Trevoux, Patissier, 1'ac quoted from Paillot, L'infection chez les insects.

> sease known as sacbrood of the honey r. The type, and only, species is

feluced disease: In the honey bee, softure stages only are susceptible; inthe larvae die, usually after capping, tulf the dead brood being uncapped by allees On asionally caps are puncey Affected areas of comb are usu-"small and scattered. Lach larva is duded along its cell, head turned up-Honard the rool A larva recently Mappears light yellow, light gray, or At brown, soon darkening to brown or

Cutiele of dead larva 223, permitting extraction of the auc-

byat black

like mass without rupture; contents watery with many suspended, fine, brown particles. There are no characteristic intracellular bodies in affected tissues. Dead larvae eventually dry down to form seales that are black and roughened, that separate readily from the cell wall, and that may be lifted out intact. Colonies tend to lose virus spontaneously.

Transmission: By contamination of food. Not by hands, clothing, or tools. Perhaps through water supply of insects.

Thermal inactivation: In water at 58°

C in 10 minutes. In honey, at 70 to 73° C in 10 minutes.

Filterability: Passes Berkefeld and Pasteur-Chamberland filters.

Other properties: Withstands drying 20, not 22, days, exposure to sunlight? hours or less, storage in honey a month or more, \(\frac{1}{2}\) to 2 per cent aqueous solutions of antholic acid 3 weeks or more.

Literature: McCray and White, U. S Dept. Agr., Dept. Bull. 671, 1918; White, U. S. Dept. Agr., Bur. of Entomol., Cire 109, 1913; U. S. Dept. Agr., Dept. Bull. 92, 1914; tbid., Dept. Bull. 431, 1917.

#### FAMILY II. BORRELIOTACEAE FAM. NOV.

Viruses of the Pox Group, inducing diseases characterized in general by discrete primary and secondary lessons of the nature of macules, papules, vesicles, or pustules.

#### Key to the genera of family Borreliotaceae.

Viruses of the Typical Pox-Disease Group.

Genus I. Borreliota, p 1229.

II. Viruses of the Varicella Group

Genus II. Briareus, p 1233

III Viruses of the Herpes Group.

Genus III. Scelus, p. 1234.

IV. Viruses of the Foot-and-Mouth-Disease Group. Genus IV. Hostis, p. 1239

V. Viruses of the Wart-Disease Group. Genus V. Malitor, p. 1240.

#### Genus I Borreliota Goodpasture.

(Science, 77, 1933, 121.)

Viruses of the Typical Pox-Disease Group, inducing diseases characterized by formation of papules, pustules, and scabs, shed with or without scarring. Generic name from Borrel, investigator who first discovered the specific granules of fowl pox and Latinized name of the smallest Greek letter, iola, signifying smallest particle. The name Cytorycles sarolate Guarnici 1852 was based on intacellular inclusions, Guarnicri bodics, as supposed sporozoan parasites (Calkins, Jour. Med. Res., 11, 1901, 136-172).

The type species is Borreliota arium Goodpasture.

#### Key to the species of genus Borreliota.

I. Affecting domestic fowl,

1. Borreliota avium.

II Affecting man principally, although strains have become adapted to cow, rabbit, etc.

2 Borreliota variolae.

III Affecting swine.

3. Borreliota suis.

1 Borrellota avium (Lipschütz) Goodpachütz, in Kolle, Kraus and Uhlenhuth, Handbuch der pathogenen Mikroorginismen, 3 Auft., 8, 1930, 314, Goodpasture, Seience, 77, 1933, 121) From Latin the names Kikuth's canary virus and pigeon-pox virus.

are, fewl of the air.

Common names Fowl-pox virus; also known as poultry-pox virus, chicken-pox virus (but not the virus of the same name attacking man rather than the chicken), or virus of epitheloma contagiosum of lowls; strains have been studied under

Hoste Chicken, turkey, pigeon, goose, duck, guinea fowl, quail, hawk, pheasant, partridge, bunting sparrow, canary. Experimentally, also English sparrow, chick embryo.

Insusceptible species: Man, gort, sheep, mouse, rat, guiner pig.

Geographical distribution: Europe, Asia, North America; perhaps coextensive with the area in which chickens are grown under conditions of domestication.

Induced disease: In chicken, hyperplastic nodular lesions of the skin, diphtheritic membranes in mouth and throat. discharges from eyes and nose; nodules eventually dry up and fall off, usually without leaving scars. Inclusion bodies, known as Bollinger bodies, believed to represent aggregates of minute Borrel bodies or virus particles, leave much grayish-white ash when incinerated; break readily after digestion by 1 per cent trypsin in 0.2 per cent sodium bicarbonate. Borrel bodies coccoid, 0.25 microns in diameter. On choricaliantoic membrane of chick embryo, proliferation and hyperplasia, or necrosis.

Transmission: By contact, perhaps through wound infection. By bloodsucking dipterous insects. Experimentally, by scarification of skin or buccal mucosa; by intravenous, intradermal, subcutaneous, intramuscular, or intraperitoneal inoculation. May be passed in series by nasal instillation in chickens. obvious mucosal changes occurring only occasionally Experimentally, by mosquitoes (CULICIDAE), Aèdes aegupti L., A. stimulans Walker, A. vexans Meigen (as long as 27 days from time of feeding on infective material), and Culex pipiens L. (indefinitely after infective feeding, as long as the individual mosquito lives); in C. pipiens, the virus has been found also under natural conditions.

Serological relationships: Neutralizing and elementary-body-agglutinating antisers specific. Antivaccinial serum from rabbit ineffective against fowl-pox virus, although neutralizing vaccinia virus.

Immunological relationships: No cross immunity with respect to vaccinia virus in the chicken.

in the chicken.

Thermal inactivation: At 60° C in 8 minutes: at 56° C in 30 minutes.

Filterability Passes Berkefeld V, not Chamberland La, filter candle.

Other properties: Drying at room temperature in vacuo does not inactivate. Viable after storage at least 24 months at 0 to 4° C. dry.

at 0 to 4° C, dry. Strains: A strain known as Kikuth's

canary virus has been studied in some detail. When introduced into the rabbit it induces formation of neutralizing antibodies that react strongly with homologous virus, moderately against fowl-pox virus. Antivaccinial serum is ineffective against it. In canaries, it induces proliferation of dermal epithelium with cytoplasmic inclusions, the inflammatory process being characterized by predominantly mononuclear cells with vacuolated cytoplasm; in the lung there is massive accumulation of large mononuclear cells containing the specific cytoplasmic inclusions; the disease is regularly fatal. Passes Berkefeld N filter. Size estimated as 120 millimicrons by centrifugation. (Bechhold and Schlesinger, Ztschr. f. Hyg., 115, 1933, 354-357; Burnet, Jour. Path, and Bact., 37, 1933, 107-122; Burnet and Lush, Brit. Jour. Exp. Path., 17, 1936, 302-307; Gaede, Cent. f. Bakt., I Abt., Orig., 135, 1935, 342-346; Kikuth and Gollub, ibid., 125, 1932, 313-320.)

Literature: Andervont, Am. Jour. Hyg., 6, 1926, 719-751; Brandly and Danlap, Jour. Am. Vet. Med. Assoc., 95, 1939, 340-349; Brandly et al., Am. Jour. Vet. Res., 2, 1941, 199-192; Brody, Cornell Agr. Exp. Sta. (Ithaca). Memoir 195, 1936; Buddingh, Jour. Exp. Med., 67, 1938, 933-940; Burnet and Lush, Brit. Jour. Exp. Path., 17, 1936, 302-307; Danks, Am. Jour. Path., 8, 1932, 711-716; Findlay, Proc. Roy. Soc. London, Ser. B, 102, 1928, 351-379; Goodpasture and A. M. Woodruff, Am. Jour. Path., 6, 1930, 699-712, Goodpasture and C. E. Woodruff, ibid., 7, 1931, 1-8; Irons, Am. Jour. Hyg., 20, 1934, 329-351; Kligler and Ashner, Proc. Soc. Exp. Biol. and Med., 28, 1931, 463-465; Kligler et al., Jour. Exp. Med., 49, 1929, 649-660; Ledingham, Lancet, 221, 1931 (2), 525-526; Ludford and Findlay, Brit. Jour. Exp. Path., 7 1926, 256-264; Matheson et al, Poultry Science, 10, 1931, 211-223; Megrail, Am. Jour. Hyg , 9, 1929, 462-465; Nelson, Jour. Exp. Med., 74, 1911, 203-212; A. M. Woodruff, and Goodpasture, Am. Jour.

Path., 7, 1931, 209-222; C. E. Woodruff, 1bid., 6, 1930, 169-174; C. E. Woodruff, and Goodpasture, 1bid., 5, 1929, 1-10, 6, 1930, 713-720.

 Berreliota variolae (Lipschütz) Goodpasture. (Sirongiloplasma raviolae Lipschütz, in Kolle, Kraus and Ullenhuth, Handbuch der pathogenen Mikroorganismen, 3 Aufl., 8, 1930, 317; Goodpasture, Science, 77, 1933, 121.) From New Latin cariola, smallpox.

Common names Variola virus, smallpox virus. Most studies of this virus have been concerned with the vaccinia strain; see Strains below.

Hosis Man, cow and rabbit are susceptible to strains that appear especially adapted to them (see Strains below). Experimentally, also chicken (and chickmurca). Chysensys merginata, turtle, guinea pig, horse, pig, Macaca mulatia (Zimmerman), thesus monkey, M. riva, cynomolgus monkey, orang-outang; Maceaus fuscatus.

Geographical distribution: Nearly world-wide, except where excluded by isolation or protective vaccination.

Induced disease: In man, mild to severe smallpox, sometimes with pocks few and discrete but often with pocks numerous and coalescing, onset sudden. 6 to 22 days (average 12) after infection headache, vomiting, fever, often rashes on body before appearance of the specific eruption, bright red spots becoming vesicular and eventually pustular, the pocks are commonest on face, forearms, wrists, raims of hands, and soles of feet; pustules gradually become flattened scabs and drop off, leaving no sear if superficial and not secondarily infected; in hemorrhagie smallrest there are numerous hemogrhages into the skin and mortality is high, death often preceding formation of pustules; severity of disease and mortality roughly proportional to the amount of cruption on the face

Transmission By contact with infected individuals or contaminated articles, perhaps by droplet infection,

obvious primary lesions characterizing experimental transmission by scarification but not natural spread.

Sarological relationships: Hyperimruma calf serum neutralizes virus. Neutralization depends on an antibody not involved in agglutination and precipitation. Antivaccinial serum gives complement fixation in the presence of variola virus. One agglutinogen (L) labile at 56° C. one (S) stable at 95° C: both are parts of a single protein but can be degraded independently; chymotrypsia destrong activity of S. not L. Increasing neutenlization in immune serum and virus mixtures in vitro with progressive incubation: partial reactivation on simple dilution. Antivaccipial sera agglutinate Paschen bodies of vaccinia but not Borrel bodies of fowl pox; anti-fowl-pox sera agglutinate Borrel but not Paschen bodies. No cross reactions with berpes virus.

Immunological relationships: In vaccinia-numune artine, protective substances pass via colostrum, conveying passive immunity to young for 2 to 3 months after birth. In man, immunity against variola virus is conferred by estlier infection with vaccina strain. In hon, previous infection with fowl-pox virus does not immunite with respect to vaccinat virus.

Thermal mactivation: At 55° C in 20 minutes.

Filterability . Passes Berkefeld V, not Mandler, filter.

Other properties: Density about 1.16. Sedimentation constant 5000 × 10<sup>-11</sup> (corrected to water at 20° C). Retains activity in glycerune leat at plf 7.0. 0 1 per cent gelatin delays spontaneous innerties tion at 5 to 10° C. Withstands absolute alcohol, ether, acctone, and petroleum ether 1 hour in dry samples at 4° C without decrease in activity. Insertiested without disruption by sonic vibratices of about 5000 cycles per second. Drameter estimated as 123 to 175 millimicrons by filtration; 236 to 232 millimicrons by ultracentrifugation. Electron micrographs show havining surface.

membrane, dense granules (usually 5) within; tendency to rectangular outlines with rounded corners. At least 5.6 per cent of virus is reported to be thymonucleic acid. Contains nitrogen, 15.3 per cent; carbon, 33.7 per cent; phosphorus, 0.57 per cent; phospholipid (lecithin), 2.2 per cent; neutral fat, 2.2 per cent; reducing sugars after hydrolysis, 2.8 per cent; cystine, 1.9 per cent; copper, 0.05 per cent.

Strains: Besides the typical variola strain, var. hominis Goodpasture (Science, 77, 1933, 121), several distinctive strains have been studied. A spontaneous cowpox strain differs in some antigens but affords cross immunity with respect to var. bous Goodpasture (loc. cit., 121), vaccinia virus, which in turn immunizes against typical variola virus. A spontaneous rabbit-pox strain, serologically resembling neurovaccine virus, is believed to exist independently in Europe and the United States. The varieties eoui (horse-pox virus), porci (swine strain), and ovium (sheep and goat pox virus) have been attributed to this species by Goodpasture (loc. cit., 121). The alastrim strain (causing variola minor) differs from the type in producing a relatively mild disease in man and in inducing the formation of a distinctive type of intracellular inclusion in affected tissues.

Amies, Jour. Path and Laterature Bact., 47, 1938, 205-222, Andervont, Am. Jour. Hyg., 7, 1927, 801-810, Behrens and Ferguson, Jour Inf. Dis., 56, 1935, 84-88; Behrens and Nielson, ibid., 56, 1935, 41-48; Buddingh, Am. Jour. Hyg., 88, 1943, 310-322; Craigie and Wishart, Brit. Jour. Exp. Path., 16, 1934, 390-398; Jour. Exp. Mcd , 64, 1936, 819-830, Dearing, Am. Jour. Hyg., 20, 1934, 432-443; Douglas et al., Jour. Path. and Bact., 32, 1929, 99-120; Downie, Brit. Jour. Exp Path., 20, 1939, 158-176; Eagles, thid., 16, 1935, 181-188; Elford and Andrewes, Brit. Jour. Exp. Path , 13, 1932, 36-42, Goodpasture, Woodruff, and Buddingh, Am. Jour. Path., 8, 1932, 271-282; Green et al., Jour. Exp. Med., 75, 1942, 651-656,

Greene, ibid., 61, 1935, 807-831; Herzberg Zischr. Immunitatsforsch. u. exper Therap., 86, 1935, 417-441; Hongland et al., Jour. Exp. Med., 71, 1940, 737-750; 78 1940, 139-147; 74, 1941, 69-80, 133-144 76, 1942, 163-173; Hu et al., Jour. Exp. Med., 68, 1936, 353-378; Keogh, Jour. Path. and Bact., 43, 1936, 441-451; Ledingham, Brit. Jour. Exp. Path., 5, 1924, 332-349; Jour. Path. and Bact., 35, 1932, 140-142; Macfarlane and Dolby, Brit. Jour. Evp. Path., 21, 1940, 219-227; Macfarlane and Salaman, ibid., 19, 1938. 184-191; McFarlane et al., 1bid., 20, 1939, 485-501; Moriyama, Arch. f. Virusforsch., 1, 1940, 422-429; Nelson, Jour. Evp. Med., 60, 1934, 287-291; 78, 1943, 231-239; Nye and Parker, Am. Jour. Path., 5, 1929, 147-155; Parker, Jour. Evp. Med., 67, 1938, 361-367, 725-738; Parker and Muckenfuss, Jour. Infect. Dis., 53, 1933, 44-54; Parker and Rivers, Jour. Exp. Med., 62, 1935, 65-72; 64, 1936, 439-452, 65, 1937, 243-249; Paschen, Deutsch. med. Wehsehr., 59, 1913, 2132-2136; Pearce et al., Jour. Exp. Med., 65, 1936, 241-258, 491-507; Jour. Path. and Bact., 43, 1936, 299-312; Pickels and Smadel, Jour. Exp. Med., 68, 1938, 583-606; Rhodes and van Rooyen, Jour. Path. and Bact., 44, 1937, 357-363, Rivers and Ward, Jour. Exp. Med., 68, 1933, 635-618; 62, 1935, 549-560; Rivers et al., abid., 65, 1937, 677-685; 69, 1939, 857-866; Rosahn et al., Jour. Exp. Med., 63, 1936, 259-276, 379-396, Rosenau and Andervont, Am. Jour. Hyg., 13, 1931, 728-740, Salaman, Brit. Jour. Exp. Path., 18, 1937, 245-258; Shedlovsky and Smadel, Jour. Exp. Med., 75, 1942, 165-178; Smadel and Rivers, ibid., 75, 1942, 151-164, Smadel et al., ibid., 68, 1938, 607-627; 71, 1940, 373-389; 77, 1943, 165-171, Smith, Jour. Path. and Bact., \$3, 1930, 273-282, Sprunt, Proc. Soc. Exp. Biol. and Med., 51, 1942, 226-227; Jour. Exp. Med., 75, 1942, 297-304; Stritar and Hudson, Am. Jour. Path., 18, 1936, 165-174; Ward, Jour. Exp. Med., 50, 1929, 31-40.

3. Borreliota suis spec. nov. From Latin sus, swine.

Common name: Swine-pox virus (not

the vaccinia strain of variola virus in swine). Host · SUIDAE—Sus scrofa L., domes-

tic swine.
Insusceptible species: Rabbit.

Geographical distribution: United

States (lowa).

Induced disease: In anine, locally, reddened hyperemic papiles 3 to 7 mm in
diameter; papules become briefly vesicular, then change gradually to true pustules, finally forming dark brown to
blackish scabs which are shed after a few
well and the starting; no secondary
lesions in hogs free from hee, but in infested animals numerous secondary lespons appear 1 to 2 weeks after primary
lesions and are commonly most numerous
in the inguinal and availary regions.
Mortality negligible but growth retarded.

Virus has been recovered from hog louse after feeding on affected swine.

Transmission By hog louse, Haematopinus suis (HAEMATOPINIDAE), probably mechanically. By experimental scarification of skin.

Serological relationships. No reaction with neutralizing sera specific for vac-

cinia virus.

Immunological relationships: Specific

smmunity in swine after attack, but no cross immunity with respect to vaccinia virus.

Filterability: Passes Berkefeld V and N filters.

Laterature: Csontos and von Nyiredy, Deutsch tierärzti. Wchaschr., 41, 1933, 529-532, Schwarte and Biester, Am. Jour. Vet Res, 2, 1941, 136-140, Shope, Arch. I. Virusforsch. 1, 1910, 457-467.

## Genus II. Briareus gen nov.

Viruses of the Varicella Group, causing diseases characterized by reddened spots and rings in affected tissues, becoming papular or vesicular. Generic name from Latin Briaren, name of a hundred-armed giant.

The type species is Briareus caricellae spec. nov.

## Key to the species of genus Briareus.

- I. Causing chicken pox and herpes zoster in man
  - 1. Briareus saricellae.
- II. Causing measles in man.

I Briareus varicellae apec. nor. From New Latin surscella, chicken por.

Common names: Varicella virus, chielen pox virus, much evidence for identity with so-called herpes-zoster virus has been presented.

Host HOMINIDAE-Homo sapiens L, mon

Insusceptible species: Chick embryo. Geographenel divibitution: World-side. Induced divease: In man, essally abrupt onset, rash at Erst macular, soon papular and vesicular; vesicles generally diverte, soon rupturing, healing with seah fermation and itching; separation of deeper scala may leave persistent sears; in severe cases there may be stomatica, lary cruit, and easta lections. In human shin rrafted on echoricalization is of chick

## Briareus morbillorum.

embryo, experimentally, pustular lesions as in natural disease, with intranuclear acidophilic inclusions, no gross vesiculation

Transmission By contact. By spread of droplets Children in contact with herpes soster pritients sometimes contract variedla.

Serological relationships Majority of herpes roster sera that orgitutinate roster antition also argitutinate learning bodies of varicella; complement firstion tests also indicate relationship of virus from herpes zoster and varicella. Chicken-pox sera do not floculate smallpox brain-virus antigen.

Immunological relationships: Children previously having varicella are immune to inoculation with herpes soster virus.

Literature: Amies, Brit. Jour. Exp. Path., 15, 1934, 314-320; Brain, abid., 14, 1933, 67-73; Bruusgaard, Brit. Jour. Derm. Syph., 44, 1932, 1-24; Goodpasture and Anderson, Am. Jour. Path., 20, 1944. 447-453; Havens and Mayfield, Jour. Inf. Dis., 50, 1932, 242-248; Irons et al., Am. Jour. Hyg., \$3, (B), 1941, 50-55; Kundratitz, Monateschr. Kinderheilk. 29, 1925, 516-523; Lipschutz and Kundratitz, Wien. klin. Woch., \$8, 1925, 499-503.

2. Briareus morbillorum spec, nov.

From New Latin morbilli, measles, Common name · Measles virus.

Host: HOMINIDAE-Homo sapiens L., man. Experimentally, also CERCO-PITHECIDAE-Macaca mulatta (Zimmermann), rhesus monkey, PHASI-ANIDAE-Gallus callus (L.), chick embryo (no lesions, but 30 serial passages).

Geographical distribution World-wide except in isolated communities,

Induced disease · In man, after incubation period of 7 to 21 days, bright red spots on buccal mucosa, especially near first molar tooth (Koplik's spots) followed by rash on face, head, neck, then arms,

trunk, and legs; popules often crescents, lesions usually discrete; rash fades, leaving brownish discoloration and desquamation.

Transmission: By contact. By droplets.

Serological relationships: Convalescent serum is reported to modify the course of the induced disease if administered intravenously in the pregruptive stage.

Immunological relationships: Specific immunity in man after attack.

Thermal inactivation: At 55° C in 15 minutes

Filterability: Passes Berkefeld N filter

candle and Seitz EK disks. Other properties: Viable at -35° C for at least 4 weeks. Not inactivated by 10 per cent anest hetic ether in 40 minutes. Literature: Blake and Trask, Jour. Exp. Med., 53, 1921, 385-412; Gordon and Knighton, Am. Jour. Path., 17, 1941, 165-176, Hedrich, Am. Jour. Hyg., 17, 1933, 613-636; Kohn et al., Jour. Am. Med. Assoc., 111, 1938, 2361-2364; Rake and Shaffer . Jour . Immunol ., \$8, 1940, 177-200; Rake et al., Jour Inf. Dis., 69, 1941, 65-69; Scott and Sunon, Am. Jour. Hyg., 6, 1925, 109-126.

## Genus III. Scelus gen. nov.

Viruses of the Herpes Group, inducing diseases characterized in general by resicular primary lesions, sometimes with subsequent involvement of the nervous system. Generic name from Latin scelus, rascal.

The type species is Scelus recurrens spec. nov.

## Key to the species of genus Scelus.

- I In man, cause of so-called fever blisters, herpes febrilis 1. Scelus recurrens.
- II In swine, cause of pseudorabies
- III. In monkey

- 2. Scelus suillum. 3. Scelus bela.
- IV. In rabbit, course of the induced disease in nature unknown.
  - 4. Scelus tertium.
  - In sheep, cause of ovine balanc-posthitis. 5 Scelus ulceris.
- VI In mice, cause of ectromelia
- 6. Scelus marmorans.
- VII. In cattle, cause of crosive stomatitis.
  - 7. Scelus bovinum.

mice, guinea pigs and rabbits, causing hemorrhagic senticemia

Distinctive characters, Much Pseudomanas nunctata (Guthrie and Hitchner, Jour. Baet., 45, 1943, 52). Source: Isolated from from dead of senticemia (red leg).

Habitat: Water and infected fresh water animala

38. Pseudomonas ichthyosmia (Hammer) comb. nov. (Bacillus ichthuosmius Hammer, Iowa Agr Sta Res Bul 38, 1917; Escherichia ichthuosmia Bergey et al., Manual, 1st ed., 1923, 201, Proteus ichthyosmius Bergev et al , Manual, 4th ed , 1934, 364) From Greek, ichthys, a fish; osmë, an odor.

Rods: 06 to 0.8 by 1.0 to 21 microns, occur singly. Motile with a single polar flagellum (Breed). Gram-negative

Gelatin stab: Liquefaction

Agar colonies: Small, white, becoming darker with are.

Agar slant : Dirty white, viscid growth Broth Turbid with gray sediment

Litmus milk. Acid. Litmus reduced Cultures have fishy odor

Potato: Thin, glistening layer

Indole is formed.

Nitrites produced from nitrates Acid and gas from glucose, fructose, galactose, maltose, sucrose, glycerol, salicin and mannitol. Lactose, dulcitol, raffinose and inulin not fermented

Aerobic, facultative.

Optimum temperature 20°C Source: Isolated from can of evaporated

milk having a fishy odor. Habitat: Not known.

39. Pseudomonas ambigua (Wright) Chester. (Bacillus ambiguus Wright, Memoirs Nat. Acad Sci. 7, 1895, 439, Chester, Man. Determ. Bact., 1901, 308; Achromobacter ambiguum Bergey et al, Manual, 1st ed , 1923, 148 ) From Latin, ambiguus, doubtful, uncertain.

Small rods, with rounded ends, occurring singly, in pairs and in chains Mo-

tile, possessing a polar flagellum. Gramnegative

Gelatin colonies: Gray, translucent, slightly raised, irregular, radiate, with transparent margin.

Gelatin stab · No liquefaction.

Agar slant. Gray, limited, entire. Broth: Turbid, with gray sediment. Litmus milk · Acid, slowly coordated. Potato: Gray to creamy, viscid.

spreading. Indole is formed.

Nitrites not produced from nitrates. Aerobic, facultative,

Optimum temperature 30° to 35°C. Habitat . Water

40. Pseudomonas sinuosa (Wright) Chester (Bacillus sinuosus Wright. Memoirs Nat. Acad. Sci., 7, 1895, 440; Chester, Man. Determ. Bact., 1901, 307; Achromobacter sinosum (sic) Bergey et al., Manual, 1st ed , 1923, 148.) From Latin, sinuosus, full of bends, sinuous

Medium-sized rods, with rounded ends. occurring singly, in pairs and in chains. Motile, possessing two to four polar flagella Gram-negative.

Gelatin colonies: Thin, translucent. irregular, center brownish.

Gelatin stab. Gravish-white, glisten-

ing, translucent No liquefaction. Agar slant Scanty, gravish growth, Broth. Turbid, with gray sediment.

Litmus milk: Unchanged. Potato. Grayish-white, moist, spreading.

Indole is formed.

Nitrites not produced from nitrates. Aerobic, facultative Optimum temperature 30° to 35°C.

Habitat, Water.

41 Pseudomonas cruciviae Grav and Thornton (Gray and Thornton, Cent. f Bakt., II Abt., 78, 1928, 91; Achromobacter cruciviae Bergey et al., Manual, 3rd ed , 1930, 218 ) From Latin, crux, a cross, 11a, way, road; from Wayeross, a place name.

f. Hyg., 115, 1933, 342-353; Bedson, Brit. Jour. Exp. Path., 12, 1931, 254-260; Bedson and Bland, ibid., 9, 1928, 174-178; Blanc and Caminopetros, Compt. rend. Soc. Biol., Paris, 84, 1921, 859-860; Boak ct al., Jour. Exp. Med., 71, 1940, 169-173; Brain. Brit. Jour. Exp. Path., 13, 1932, 166-171; Buggs and Green, Jour. Inf. Dis., 58, 1936, 98-101; Burnet and Lush, Jour, Path. and Bact., 48, 1939, 275-286; 49. 1939, 211-259; Lancet, 236, 1939 (1). 629-631; Burnet et al., Austral. Jour. Exp. Biol. and Med. Sci., 17, 1939, 35-40; Dawson, Am. Jour. Path., 9, 1933, 1-6; Elford et al., Jour, Path, and Bact., \$8. 1933, 49-54; Findlay and MacCallum. Lancet, 238, 1940 (1), 259-261 : Fischland Schaefer, Klin. Wochnschr., 8, 1929, 2139-2143; Flexner, Jour. Gen. Physiol., 8, 1927, 713-726; Jour. Exp. Med., 47, 1928. 9-36, Friedenwald, Arch. Ophthalmol., 52, 1923, 105-131; Goodpasture, Medicine, 8, 1929, 223-243; Goodpasture and Teague, Jour. Med. Res., 44, 1923. 121-138; Gunderson, Arch. Opthalmol., 15, 1936, 225-249, Holden, Jour. Inf. Dis., 60, 1932, 218-236, Keddie and Epstein, Jour. Am. Med. Assoc , 117, 1941, 1327-1330. Levaditi and Lepine. Compt. rend. Acad Sci., Paris, 189, 1929, 66-68, Levadit1 and Nicolau, Compt rend. Sec. Biol . Paris, CO, 1924, 1372-1375; Long, Jour, Clin. Investigation, 12, 1933, 1119-1125; Magrassi, Boll. Ist, Sieroterap, Milanese, 14, 1935, 773-790, McKinley, Proc. Soc. Exp. Biol. and Med., 26, 1928, 21-22, Nacgeli and Zurukzoglu, Cent. f. Bakt. I Abt., Orig , 185, 1935, 297-299, Nicolau and Kopciowska, Ann. Inst. Pasteur, 60, 1938, 401-431, Parker and Nye, Am. Jour. Path., 1, 1925, 337-340, Perdrau, Proc. Roy. Soc London, Ser. B, 109, 1931, 304-308 Jour Path and Bact., 47, 1938, 447-455; Remlinger and Bailly, Comp. rend. Soc. Biol , Paris, 94, 1926, 734-736; 1064-1066, 95, 1926, 1512-1545; 96, 1927, 404-406; 1126-1128, 97, 1927, 109-111, Sabin, Brit, Jour Exp Path., 15, 1934, 372-380; Schultz and Hoyt, Jour. Immunol., 15, 1928, 411-419; Shaffer and Enders, ibid., 57, 1939, 383-411; Simon, International

Clinics, Series 37, 5, 1927, 123-123; Smith et al., Am. Jour. Path., 17, 1941, 55-68; Warren et al., Jour. Exp. Mad., 71, 1940, 155-168; Weyer, Proc. Soc. Exp. Biol. and Med., 59, 1932, 309-313; Zinsser, Jour. Exp. Med., 49, 1929, 661-670; Zinsser and Seastone, Jour. Immunol., 18, 1930, 1-9; Zurukzoglu and Hruszek, Cent. f. Bakt. I Abt., Orig., 128, 1933, 1-12.

2. Scelus sullium spec. nov. From Latin sullius, pertaining to spine.

Common names: Pseudorables virus, mad-itch virus.

Hosts: Domestic cattle, swine, dog, eat, horse, sheep. Experimentally, also rabilt, guinea pig, white rat, white mouse, gray field mouse, duck, chicken, chek embryo; Macaca mulaita (Zimmermana), rhesus monkey.

Geographical distribution: France, Germany, Hungary, Holland, Denmark, Switzerland, Siberia, Brazil, United States.

Induced disease: In cattle, licking of affected area, usually somewhere on hind-quarters, sudden decrease in milk production in dairy animals, unlent rubbing, biting, and gnawing of lesion; swelling and discoloration of affected parts with cozing of serosanguineous fluid; grinding of teeth and evessive salivation in some individuals; death, preceded by clonic convulsions, violent tossing of head, and shallow respiration, usually 36 to 48 hours after onset. In pig, mild but highly contagious disease; slight nerve-cell degeneration, predominance of vascular and interstitual lesions.

Transmission: By contact in swine, not in cattle. By feeding in cats, brown rats, and swine.

Serological relationships: Cross neutralization between constituent strains. Anti-herpes sera protect in some cases against small, but constantly infective, doses of pseudorabies virus.

Literature: Aujeszky, Cent. f. Bakt. I Abt., Orig., 52, 1902, 353-357; F. B. Bang, Jour. Exp. Med., 76, 1942, 263-270;  Seelus recurrens epec. nos. From Latin recurrer, to recur. Note: The name Neurocyti's herpeti' Levaditi and Schoen (Compt. rend. Soc. Biol., Paris, 95, 1927, 961) was applied provisionally to the causative microorganism of herpes, in the expectation that future research would show inclusion bodies in affected tissues to be stagos in its life cycle.

Common names: Herpes virus, virus of herpes simplex, virus of herpes febrilis (not herpes zoster virus, for which see varicella virus), virus of heratitis dendritica, virus of aphthous stomatitis (of man).

Host. HOMINIDAL—Homo santers L, man. Experimentally, also rabbit, guinea pig, white mouse, eat, goose, hedge-heg, and, though difficult to infect, dog and pigeon. Chick embryo (but not chicken). Also CEECOPITIECIDAE—Cercoccus Julyanous E. Geoffrey, Macteus cynomolgus, CEBIDAE—Ce-bus oliratesis.

Insusceptible species: White rat, Bufo viridis; Cercopithecus callithriz; chicken (except embryo).

Geographical distribution; Probably world-wide.

Induced disease. In man, usually acquired in first three years of life, sometimes as aphthous stomatitis; virus probably retained often through life, sometunes with periodic reappearance of dermal legions, which are vesicular and heal soon. In white mouse, by experimental inoculation of skin, small inflamed vesicular primary lesions about 5 days after anoculation, usually forming scales and healing a few days later, but sometimes persisting, if on tail, followed by swelling and paralysis of tail, ascending paralysis and death, or by recovery with acquired immunity, if near head, followed by encephalitis and death, intraperitoneal and sometimes other inoculations immunize. relapse with recurrence of primary lesions rare. In chick embryo, white, on one circular or ring like primary lesions of small size on choricallantoic membrane. with or without perrotic secondary lesions in liver, heart, lungs, spleen, and kidneys; virus enters membrane 1 to 4 hours after it is dropped on its surface; primary lesions may be counted in 18 hours

Transmission: By contacts. Experimentally, by skin scarification; in guinea pig, by feeding.

Serological relationships: Distant relationship to pseudorables virus, Scelus saullum, shown by moderate protection against this virus conferred by some antiherpes sera. No relationship to vacchia virus or to virus III of rabbits demonstrable by neutralization tests. Specific complement fixation. Neutralizing antibody forms reversible union with virus, at least for a time, though with strong mixtures partial irreversibility finally occurs.

Immunological relationships: Formalinized virus and non-lethal strains of virus immunize specifically. No cross immunity with vaccina virus.

Thermal mactivation: At 50 to 52° C in 30 mnutes, when moist, at 90 to 100° C in 30 mnutes, when dry. At 41 5° C in 50 to 80 hours.

Filterability Passes Berkefeld V filter with slight loss.

Other properties Diameter, by centrifugation, computed as 180 to 220 mill: microns; by filtration, 100 to 150 millimicrons; by filtration, 100 to 150 millimicrons. Specific gravity, 1.15. In-activated by repeated freezing and thrwing, also by pressure of 3000 atmospheres for 30 minutes. Visible dry at least 18 months at 4°C, in 50 per cent algorithm at least 6 months. Not inactivated at 4°C in 1 per cent aqueous gentim violet. Charged negatively in solutions of by-drogen on concentration up to about pil 8. Isselectric point, pil 7.2 to 7.6. In-activated by incubvion in rito at pil 6 with aynthetic vitamin C (ascorbic acid.)

Literature Anderson, Science, 50, 1993, 497; Am. Jour. Path., 16, 1910, 137–156, Andersont, Jour. Inf., Dis. 44, 1929, 333–334; 45, 1929, 336–335, 42, 1931, 507–529, Andrews, Jour. Path. and Bact., 59, 1930, 301–312; Bussett et al., Compt. rend. Aerd. Seu., Paris, 260, 1931, 1882–1884; Beckhold and Schlesinger, Ztechr. 1884; Beckhold and Schlesinger, Ztechr.

weeks in 50 per cent glycerine and 16 months dried when frozen, and stored on ice.

Literature: Andrewes, Brit. Jour. Exp. Path., 10, 1929, 188-199, 273-289; Jour. Path. and Bact., 35, 190, 301-312; 50, 1940, 227-234; Rivers and Stewart, Jour. Exp. Med., 48, 1928, 603-613; Rivers and Tillett, 15td., 39, 1924, 777-802; 40, 1921, 281-287; Topacio and Hyde, Am. Jour. Hyr., 15, 1932, 99-124.

 Scelus ulcerls spec. nov. From Latin ulcus, sore spot.

Common name. Ovine balano-posthitis

Host: BOVIDAE-Ovis aries L., sheep.

Geographical distribution: United States, Australia.

Induced disease: In sheep, ulceration with seab production: lesions most severe on prepue and vulva; in the male, the penis may be involved, usually only with mild inflammation, but if accompanied by paraphimosis there may be extensive ulceration and heavy seab formation.

Transmission: Venereally. Experimentally, by inoculation of prepuce.

mentally, by inoculation of prepuce.

Filterability. Passes Berkefeld N and
W filters, a 7 lb Mandler candle, and a 34

per cent collection membrane.

Literature Tunnicliff and Matisheck, Science, 94, 1941, 283-284.

 Scelus marmorans spec. nov. From Latin marmorare, to marble, in reference to mottling of spicen and liver in host. Common name. Ectromelia virus.

Hosts: MURIDAE—Mus musculus
L., white mouse. Esperimentally, also
MURIDAE—Rattus norregucus (Berkenhout), rat (infection inapparent).
Also, PHASIANIDAE—Gallus gallus
(L.), chack embryo (12-day-old White
Leghorn chick embryo at 36 to 37° C;
less satisfactory results at higher temperatures of incubation or in embryos in
spring eggs/k. Derived strains of this
virus infect rabbit and guines pig, not
susceptible to original virus from mouse.

Geographical distribution: England.

Induced disease: In white mouse. spleen mottled, liver edges translucent peritoneal fluid increased in amount ; loss of weight: later, cutaneous lesions on foot or elsewhere; affected foot swells, becomes moist, scabbed, then recovers or dries up and separates from the skin at limit of original swelling; in acute disease, death without gross lesions, or, at autonsy, gut dark red, liver dirty gray, soft, bloodless, sometimes mottled, spleen necrotic; inclusion bodies most numerous in lesions of the skin, round or oval, 4 to 13 microns long, without internal differentiation; very young mice probably become infected without developing apparent disease and remain carriers for some time. In rat, inapparent infection; after initial increase of virus, circulating antibodies appear and immunity to reinfeetion is established.

Transmission: In mouse, by contact.

In rat, experimentally, by intranasal inoculation.

Serological relationships: Neutralizing antibodies occur in convalescent mouse serum. Immune sera from the guineapig specifically agglutinate elementary bodies obtained from infected skin of the white mouse.

Immunological relationships: Recovered mice are solidly immune to many lethal doses.

Thermal inactivation At 55° C in 30, not in 10, minutes.

Filterability . In broth, passes Mandler, Pasteur-Chamberland Lz, and Berkefeld N filters.

Other properties: Survives drying 6 months, freezing (-10° C) 2 months, 50 per cent glycerine 5 months at least. Resists 1 per cent phenol 20, not 40, days. Size, estimated by filtration, 100 to 160

48, 1936, 105-120, Jahn, Arch. t. Virusforsch., 1, 1939, 91-103; Kikuth and O. Bang, Acta path. et microbiol. Scand., Suppl., 11, 1932, 180-182; Carini and Macuel, Bull, Soc. Path. exot., 5, 1912, 576-578; Følger, Acta path, et microbiol. Scand., Suppl., 11, 1932, 182-187; Glover, Brit. Jour. Exp. Path., 20, 1939, 150-158, Gowen and Schott, Am Jour, Hyg., 18, 1933, 674-687, Hurst, Jour. Exp. Med , 58, 1933, 415-433, 59, 1934, 729-749; 63, 1936, 419-463, Koves and Hirt, Arch. missensch u. prakt. Tierheilk., 68, 1931. 1-23 , Morrill and Graham, Am. Jour. Vet. Res , 2, 1941, 35-40; Brit, Jour. Exp. Path., 15, 1931, 372-380; Shope, Proc. Soc Exp. Biol. and Med., 50, 1932, 308-309 Jour. Exp. Med., 54, 1931, 233-218; 87, 1933, 925-931, 62, 1935, 85-99, 101-117, Traub, ibid , 58, 1933, 663-681; 61, 1935. 833-838

 Scelus beta spec. nov. From beta, second letter of Greek alphabet, in reference to common name.

Common name B virus.

Hosts HOMINIDAE—Homo suprens L, man. CERCOPITHECIDAE—Macaca mulutta (Zummermann), rhesus monkey L'uperimentally, also LEPOR-IDAE—Oryclologus cuniculus (L.), rabbut CAVIIDAE—Cavia porecllus (L.), guinca pig.

Geographical distribution United States (from captive monkeys and man) Induced disease. In man, local and rela-

tricky magnificant lesion on latten part, itee flaccid paralysis of legs, urmary tention, seconding paralysis, and death by respiratory failure. In Macaca mulatio experimentally by intraculanceous injection, hemorrhagic or sessionly pustular lesions without later involvement of central nervous system but with subsequent acquired immunity. Acidophilic intranuclear inclusions is lesions.

Transmission To man, by bite of monkey To monkey, experimentally, by injection

Literature Burnet et al., Austral. Jour. Exp. Biol. and Med. Sci., 17, 1939, 35-40, 41-51, Sabin, Brat. Jour. Exp. Path., 15, 1931, 218-268, 268-279, 321-331; Sabin and Hurst, 16id., 16, 1935, 133-148; Sabin and Wright, Jour. Exp. Med., 59, 1931, 115-136.

4. Scelus tertium spec. nov. From Latin tertius, third.

Common name: Virus III of rabbits.

Host LEPORIDAE—Oryctologus cuniculus (L.), domestic rabbit.

Irsusceptible species. No obvious disease in inoculated guinea pig, white mouse, monkey (Macaca mulatta Zimmer mann), rat, or man, hence the assumption that these are naturally immure, but they may be merely tolerant or klendasse.

Geographical distribution: United States (apparently spontareous in some individuals of the laboratory rabbit).

Induced disease. In domestic rabbit. experimentally, after incubation period of 4 to 6 days, failure to eat, loss of weight, occasionally diarrhea and temperatures of 104 to 107° F; small, superficial, red spots and papules on skin at site of inoculation, local infiltration of tissues with endothelial leucocytes, swelling of involved epithelial cells; nuclear inclusions present in endothelial leucocytes and some other cells; disease not fatal; virus in circulating blood only during early stages, recovery in a few days without sear formation but with development of specific immunity. The course of the natural disease, presumed to occur in rabbits, is still unknown

Transmission Experimentally, by injection of filtrates from diseased tissues, on several occasions also from blood or tissues of apparently normal rabbits.

Serological relationships Specific neutralizing substances occur in the serum of recovered rabbits.

Immunological relationships: Specific immunity but no cross reactions with vaccing or herpes struses.

Thermal inactivation. In 10 minutes at 55°C, but not in 30 minutes at 45°C.

Filterability, Passes Berkefeld V and N filters, passes L filter candle.

Other properties: Viable at least 6

in racuo, at least a week at -4 to 0° C. Readily destroyed by 1 to 2 per cent sodium hydrate or above pH 11. Soon inactivated near pH 6.0, but moderately stable at pH 2.0 to 3.0; optimum condition for storage at pH 7.5 to 7.7 in absence of air; return from 3.0 to 7.5 inactivates, however.

Literature: Elford and Galloway, Brit. Jour. Exp. Path., 18, 1937, 155-161; Galloway and Elford, thid., 14, 1933, 400-408, 16, 1935, 588-613; 17, 1936, 187-204; Galloway and Schlesinger, Jour. Hyg., 87, 1937, 463-470; Hare, Jour. Path, and Bact., 55, 1932, 291-293; Loeffler and Frosch, Cent. f. Bakt., I Abt., 25, 1898, 371-391, Matte and Sanz, Bull. Soc. Path. Exot., 14, 1921, 523-529; Olitsky and Boez, Jour. Exp. Med., 45, 1927, 673-683, 685-699, 815-831, 833-848; Pyl, Ztschr. f. physiol. Chemie. 226, 1934, 18-28; Pyl and Klenk, Cent. f. Bakt., I Abt., Orig., 128, 1933, 161-171; Schlesinger and Galloway, Jour. Hyg., 37, 1937, 445-462.

2. Hostis equinus spec. nov. From Latin equinus, pertaining to horses.

Common names: Vesicular stomatitis virus.

Hosts. Horse, domestic cattle. Experimentally, also gunea pig, swine, white mouse, rabbit (rolatively resistant), chick embryo; Macaca mulatia (Zimmermann), rhesus monkey, M. trus, evpomoligus monkey.

insusceptible species: Chicken (ex-

United

cept embryo).
Geographical distribution:
States (Indiana, New Jersey).

Induced disease. In horse, resembles foot-and-mouth disease of cattle; red-dened patches on buccal mucosa, moderate fever, salivation, followed by appearance of vesicles, especially on tongue, filled with clear or yellowish fluid; vesicles often coalesce and soon rupture leaving an eroded surface which heals soon in the absence of complications.

Experimentally, in choricallanteis of developing chick embryo, primary lesions involve moderate ectodermal proliferation; degeneration, necrosis; mesodermal inflammation; slight endodermal proliferation.

Serological relationships: Strains isolated in different localities give antisers capable of neutralizing heterologous isolates of virus, but homologous antisers neutralize in higher dilutions than do heterologous antisers.

Immunological relationships: No cross immunity with respect to equine encephalomyelitis virus.

Filterability: Passes Seitz filter.

Other properties: May be separated from mixtures with foot-and-mouth disease virus by propagation on choiroallancie membrane of chick embryo, which will not support increase of the latter virus. Inactivated by 1:50,000 methylene blue in 2 mm layer 13 cm from 300 candle-power lamp in 60 minutes but not in 20 minutes. Particle estimated on the basis of filtration data to be 70 to 10 mllimiterons in diameter; 60 millimiterons in diameter by centrifugation. Not destroyed by acidifying to pH 3 and returning to pH 7.5 (difference from foot-and-mouth disease virus).

mouth disease: Burnet and Galloway. Brit. Jour. Exp. Path., 15, 1934, 105-118; Cox and Olitsky, Proc. &c. Exp. Biol. and Med., 59, 1933, 853-651; Cox etai., 59, 1933, 595-818, Elford and Galloway, Brit. Jour Exp. Path., 18, 1937, 185-161; Galloway and Hiford, 150, 1937, 400-408, 16, 1935, 585-613; Mohler, 1933, 400-408, 16, 1935, 585-613; Mohler, 59, 1934, 150-171; Pyl., Ztschr. f., physiol. Chemic, 256, 1931, 18-23; Sabin and Chemic, 256, 1937, 15-31, 35-57, 507, 1938, 201-293, 229-219; Syverion et al., Science, 78, 1933, 216-217.

Gönnert, Arch. f. Virusforsch., I, 1940, 293-312, Marchal, Jour. Path. and Bact., \$5, 1930, 713-728; McGaughey and Whitehead, rbid., 57, 1933, 283-256; Paschen, Cent. f. Bakt., I Abt., Orig., 135, 1936, 415-452

7. Scelus bovinum spec. nov. From Latin borinus, of ox, bull, or cow.

Common name. Erosive-stomatitis

Rost BOYIDAE-Bos taurus L., domestic cattle. Experimentally, also choroaliantoic membrane of developing hen's egg.

Insusceptible species. CAVIIDAE— Caua parcellus (L.), guinea pig. (In rats, rabbits, mice, sheep, no reaction has been noted after inoculation.)

Geographical distribution South Mrica (Natal); perhaps Ireland (Armagh-disease virus).

Induced disease In young domestic

cattle, lesions on tongue, dental pad, and lips pearl-like at first, then breaking down to form superficial erosions, with white glistening base and red border. Lesions may coalesce to form large, ragged, eroded areas, healing uneventfully with sear formation. No foot lesions; no excessive salivation, no "hotness" of mouth; no systeme disturbances.

Transmission. Spreads slowly, mainly to animals less than three years old, probably by contact. Experimentally, by injection into dental pads, lips, or tongue. Filterability. Passes Gradocol membrane of about 400 millimieron average pore diameter.

Other properties. Viable after at least 11 days at room temperature, 21 days at refrigerator temperature, 6 weeks frozen and dried in horse-serum saline.

Literature: Mason and Neitz, Onderstepoort Jour. Vet. Sci. and Anim. Indust., 15, 1940, 150-173.

## Genus IV. Hostis gen. nov.

Viruses of the Foot-and-Mouth Disease Group, inducing diseases mainly characterized by vesicular lesions Generic name from Latin hostis, enemy or atronger. The type exercise is Hostic peceris spec nor

## Key to the species of genus Hostls.

- Infecting cattle and other animals with cloven hoofs; horse immune or highly resistant.
- 11 Infecting horse readily
- 1. Hostis pecoris spec. nov. From Latin pecus, cattle.
- Common names Foot and-mouth discase virus, Virus der Maul- und Klauenseuche.

Hoste Cow, pig, sheep, goat, reindeer, boson Experimentally, also guinea pig, milibit, rat.

Insusceptible species. Chick embryo (charmellimins), horse (immune or very resistant).

Induced disease. In cow, after incubation period of 2 to 4 days or more, fever, residuar lessons on tongue, lips, guins, stabil pulste and feet, mon rupturing, salivation, lameness, generally recovery 1. Hostis pecoris.

2. Hostis equinus.

Transmission Spread rapid, source of infection often obscure, saliva is infective before lesions become obvious,

Thermal mactivation At 70° C, not at 60° C, in 15 minutes. Filterability Passey Scitz, Berkefeld

V and N, and Chamberland Lat filters. Strains Three strains, A, O and C, are simmunologically distinct from each other.

Other properties Particle calculated to be about 20 millimicrons in diameter by centraligation data, S to 12 millimicrons in diameter by filtration, may be separated from mixtures with the larger equine rescalar stomatitis uras by differential filtration. Viable after drying

1905, 1598-1599; Lipschütz, Arch. Dermat. u. Syph., 107, 1911, 387-396; in Kolle, Kraus and Uhlenhuth, Handbuch der Pathogenen Mikroorganismen, 8, 1930, 1031-1040; Van Rooyen, Jour. Path. and Bact., 49, 1933, 425-436; 49, 1939, 315-349; Wile and Kingery, Jour. Cutan. Dis., 37, 1919, 431-446.

3. Molitor bovis spec. nor. From Latin bos, cow.

Common name: Cattle-wart virus.

Host: BOVIDAE-Bos taurus L., domestic cattle.

Geographical distribution: United States.

Induced disease. In cattle, especially about head, neck, and shoulders in young animals, on udders in cows, affected skin thickened at first, then rough, nodular; warts sometimes become large and pendulous, adversely affecting growth of host; they sometimes become caulifloxer-like tumors several inches in diameter; spontaneous regression is not infrequent. Hides from affected animals are reduced in value.

Transmission: Beheved to be through injuries to skin when the injured part comes in contact with warty animals or with rubbung posts, chutes, fences, buildings, or other structures with which affected animals have come in contact previously. Experimentally, by skin inoculations, especially in animals under I year of age.

Filterability: Passes Berkefeld N filter. Literature: Creech, Jour. Agr. Res., 59, 1929, 723-737, U S. Dept. Agr., Leaflet 75, 1931, 1-4.

4. Molitor buccalis spec. nov. From Latin bucca, cheek.

Common name Camme oral-papillomatosis virus.

Host: CANIDAE-Cans familiaris

Insusceptible species Cat, rabbit, guinea pig, rat, mouse, Macaca mulaita (Zimmermann), rhesus monkey.

Induced disease: In young dog, experimentally, about I month after moculation of buccal membrane by scarification,

pale, smooth elevations, becoming gradually more conspicuous and roughened; infinily a mass of closely packed papillae is formed. Regression with subsequent immunity is frequent; no sears are left on regression. Secondary warts often appear in other parts of the mouth 4 to 6 weeks after primary warts have first been observed.

Transmission: Experimentally by skin scarification.

Scrological relationships: Not inhibited by antiserum effective against commonwart virus of man.

Thermal inactivation: At some temperature between 45 and 58° C in 1 hour. Filterability: Passes Berkefeld N filter.

Other properties: Viable after freezing and drying, if stored dry in icebox, at least 63 days; in storage in equal parts of glycerine and 0.9 per cent NaCl solution at least 64 days.

Literature: DeMonbreun and Goodposture, Am. Jour. Path., 8, 1932, 43-56; MFadyean and Hobday, Jour. Comp. Path. and Therap., 11, 1898, 341-344; Penberthy, bid., 11, 1898, 363-355.

5. Molitor tumoris spec. nov. From Latin tumor, swelling.

Latin tumor, swelling.

Common names: Foul-sarcoma virus,
Rous chicken-sarcoma virus.

Hosts: PHASIANIDAE—Gallus gollus (L.), chicken. Experimentally, also pheasant (serial transfer difficult) and duck (by cell transfer only but filtrates from duck infect injected chicken).

Insusceptible species: Turkey, guines fowl (both immune to filtrates but capable of supporting tumor line if alterated in a series with common fowl hosts); geese.

Induced disease: In hen, originally found in an adult, pure-bred hen of Barred Plymouth Rock variety. Experimentally transmitted, a circumseribed nodule soon becomes evident at site of implantation; later this becomes necrotic or cystic at its center; as growth enlarges, host becomes emacated, cold, somnolent, and finally dies; discrete metastasses are often found in lungs, heart, and liver. Parent cell of sarcoma is claimed to be

## Genes V. Molltor cen. nov.

Viruses of the Wart-Disease Group, inducing diseases mainly characterized by tissue proliferation without vesicle or pustule formation. Generic name from Latin molitor. contriver.

The type species is Molitor verrucae spec. nov.

#### Ken to the species of genus Molitor.

- I. Affecting man.
- 1. Molitor verrucae. 2. Moldor hominis.

11. Affecting cow.

- III. Affecting dog.
- 3. Meliter boris.

IV. Affecting chicken.

4. Molitor buccalis.

V. Affecting rabbit

- 5 Mobiler lumeris.
- 7 Molitor sulvilage.
- 6. Molitor gingicalis.
  - - 8. Mclitor muzomae.
- 1 Molitor verrucae spec. nou. From Latin perruea, Wart. Common name . Common-wart virus.

Arch Dermat, u. Synh., 107, 1911, 395 ) From Latin home, man. Cammon name: Molluscum contagiosum

Mosts · HOMINED AE - Homo samens L., man. Perhaps also BOVIDAE-Box taurus L. cow. CANIDAE-Cants familiaris L , doc.

Induced discase, Experimentally in man, incubation period long, 4 necks to 6 or more months, suitally acanthosis foregrowth of prickle cell layer of epidermis) and flattening of the popillae. later, interpupillary hypertrophy, invirus. Most: HOMINIDAE-Homo saviens

flammation, and marked haperkeratosis Transmission By contact, in some eases, venereally, Experimentally, by L., man. Geographical distribution. Perhaps essentially world wide. Induced disease. In man, experimen-

skin scar fication.

tally, prodromal period may be 14 to 50 days, lesions at first like pumples, becoming red, painful, swollen, developing into small tumors covered with stretched and shiny skin; lesions commonest on face. arms, buttocks, back, and sides, he iling anontaneously. Inclusions within epithelial cells, known as mólluscum bodies, measure 8 to 21 microns in diame-

ter when approximately epherical, 2t to

27 microns in width and 30 to 37 microns

in length when elongated, they contain

I dierability . Paxses Berkefeld N filter Literature Ciuffo, Giorn, ital. d. malatue venerce e d. pelle, 48, 1907, 12~ 17, Kingery, Jour Am. Med. Assoc , 70, 1921, 410-412, Payne, Brit. Jour. Dermat . 3, 1601 185-188, Schultz, Doutsch, med. Wehnschr , 54, 1908, 423; Serra, Giorn. nal d mainthe venerce e d. pelle, 65, 1921, 1406-1814, Ullmann, Acta oto-

elementary bodies about 0.3 micron in diameter. The outer envelope of the molluscum body is of carbohydrate. Transmission. By contact. By fomites Filtershility: Passes Chamberland L.

lary ngologica, 5, 1923, 317-331. Wife and hingery, Jour Am. Med. Assoc., 75, 1919, 970-973. 2. Molitar hominia comb. (Strong:loplasma kaminis Lipschutz,

and Berkefeld V filters. Literature: Goodpasture and King. Am. Jour. Path., 5, 1927, 385-391; Good-

pasture and Woodruff, shid., 7, 1931, 1-8: Juliusberg, Deutsch, med. Wehnschr., Erxleben, snowshoe hare; L. californicus Gray, jack rabbit; Sylvilagus sp., cottontail rabbit.

Geographical distribution: United States.

Induced disease: In rabbit, benign papillomas, having the form of small, discrete, gray-white, sessile or pedunculated nodules, usually multiple, on lower surface of tongue or, less frequently, on sums or floor of mouth.

Transmission: Perhaps by mother to auckling young, with a latent period before onset of disease. Not highly contagious, if contagious at all, in old animals, Experimentally by puncture of tissues in the presence of tirus.

Immunological relationships: Specific immunity develops as a result of disease, but no cross immunity with respect to rabbit-papilloma virus, which differs also in failing to get on oral nucosa.

Filterability: Passes Berkefeld V and N filters.

Literature: Parsons and Kidd, Jour. Exp. Med., 77, 1943, 233-250.

7. Molitor sylvilagi spec. nov. From New Latin Sylvilagus, generic name of cottontall rabbit

Common names Rabbit papilloma or papillomatosis virus, rabbit wart virus.

Hosts: LEPORIDAE—Sylvilogus sp., cottontail rabbit. Experimentally, also LEPORIDAE—Oryctologus cuniculus (L.), domestic rabbit.

Geographical distribution: United

Induced disease In cottontail rabbit, at first minute elevations along lines of scarification; later sold masses of wrinkled keratinized tissue, 8 to 4 millimeters in thickness, eventually cornified warts, striated perpendicularly at top, fleshy at base, 1 to 1.5 cm in height; regression rare, natural papillomas become malignant occasionally. In domestic rabbit, experimentally, blood antibody remains low but virus is always masked, preventing geral passage, discrete lesions on skin permit quantitative tests, turring causes

localization of virus from blood stream: bapillomas give rise to malignant acanthomatous tumors by graded continuous alteration; metastasis frequent; transplantation to new hosts successful in series: antibody specific for the virus is formed continuously in the transplanted growths although virus is not directly demonstrable by subinoculation from them; malignant growths appear more promptly and frequently where epidermis has been tarred long; virus appears specific for epithelium of skin; growths disappear if treated with X-rays, 3600 r at one time or fractionally; 60 per cent are cured with 3000 r. but 2000 r ineffective.

Transmission: Experimentally, by scarification of skin. Abnormal susceptibility to infection is noted in rebbit skin treated with 0.3 per cent methylcholanthrene in benzene or equal parts of turpentine and acctone.

Scrological relationships: Specific neutralization, reversible on dilution. Complement fixation specific, with virus particle as antigen; no cross reaction with antisers for vaccinia, herpes, fibroms, or myxoma viruses. Precipitates occur in properly balanced mixtures of virus and specific antiserum; virus and antibody in both free and neutralized states are present in both soluble and insoluble

phases of these suspensions.

Immunological relationships: Intraperitoneal injections mmunite specifically. Rabbits immunized to fibroma
and myxoma viruses are susceptible to
rabbit paniform virus.

Thermal inactivation: At 70° C, not at 65 to 67°C, in 30 minutes; in 0.0 per cent sodium chloride solution at 65 to 60° C, time not stated.

Filterability: Passes Berkefeld V, N, and W filters; particle sire calculated as 23 to 35 millimicrons by filtration as compared with 32 to 55 millimicrons by centrifugation and 44.0 millimicrons by centrifugation and the comparison of cleentry spherical in shape.

the normal histiceyte, but wrus in the affected fowl is not confined to the safecoma, being widespread in the body in spleen, liver, muscle, brain, etc. In the chiek embryo, serial passage is feasible on the egg membrane, in which focal lesions involve only ectodermal tissue.

Transmission. By injection of affected fool cells or filtrates. Certain transmissible tar-induced excomas, not infecting by filtrates, nevertheless induce the formation of antibodies capable of neutralizing this virus. An inhibitor of the virus extracted from tumors appears to be a protein, inactivated at 65° C, but not at 55° C, in 30 minutes and destroyed by trypin in 3 to 5 hours at pH S. Olece acid also may act as an inhibitor. No spontaneous transmission in chickens bent together.

Serological relationships: Particles sedimented by centrifugal force 20,000 to 30,000 times gravity are specifically agglutinated by sera of fowls bearing corresponding tumor. At least one antigen in tumors of hen and duck not in healthy birds, this one fixes complement and gives cross reactions with Rous, Mill Hill 2, Fujimmi, and RFD2 tumors, Virus injected into goats produces two antibodies but only one if previously heated, the antibody to the heat-stable constituent requires complement to neutralize virus, the only antibody produced in ducks does not require complement to neutralize

Thermal mactivation: At or below 51° C in 20 minutes.

Filterability Passes Berkefeld V and no 5 (medium) filters.

Other properties Particle are estimated as about 100 millimicrons (but some as) 50 or even 15 millimicrons) in dismeter by filtration through graded membranes, about 70 millimicrons (molecular weight 110,000,000) by ultracentraligation Contains 35 to 90 per cent nitrogen, 1.5 per cent phosphorus. Protein tests positive Feulpen reaction for thymonucleic acid absent, 10 to 15 per cent of the protein may be nucleic

acid, probably of ribose type. Pentose present. Virus believed to be of globulin nature or attached to globulin particles (Lewis and Mendelsohn, Am. Jour. Hyg., 12, 1930, 688-689). Viable indefinitely in dried soleen as in dried sarcoma tissues,

Strains: Several strains have been studied in addition to the original Rous sarroma no. 1 strain; immunological relationships have been shown between the original strain, the des Ligneris sarroma strain, the Fujinami sarroma strain, the fibrosarroma MHI and endothelioma MHI2 strains, other isolates also have shown serological interrelationships.

Laterature: Amies, Jour, Path. and Bact., 44, 1937, 141-166; Amies et al., Am. Jour. Cancer, \$5, 1939, 72-79; Andrewes, Jour. Path. and Bact., 54, 1931, 91-107; \$5, 1932, 407-413; \$7, 1933, 17-25, 27-41, 43, 1936, 23-33; Claude, Jour, Exp. Med., 66, 1937, 59-72; Science, 87, 1938, 467-468; 90, 1939, 213-214; Am. Jour. Cancer, 37, 1939, 59-63, Claude and Rothen, Jour. Exp Med., 71, 1910, 619-633, Dmochowski and Knov. Brit. Jour Exp. Path., 20. 1939, 466-472, Elford and Andrewes. thid., 16, 1935, 61-66; Gye and Purdy, Jour. Path. and Bact., \$4, 1931, 116-117 (Abst.); Haddow, thid , 37, 1933, 149-155; Helmer, Jour. Exp Med., 64, 1936, 333-338, Keogh, Brit. Jour Exp. Path., 19. 1938, 1-9. Ledingham and Gye, Lancet, 228, 1935 (1), 376-377, Lewis and Mendel=ohn, Am. Jour. Hyg., 12, 1930, 686-689, des Ligneris, Am. Jour. Cancer, 16. 1932, 307-321, McIntosh, Jour, Path, and Bact . 41, 1935, 215-217, Mellanby, Jour. Path, and Bact , 46, 1938, 417-160; 47. 1938, 47-61, Mendelsohn et al., Am, Jour. Hyg., 14, 1931, 421-425, Purdy. Brit. Jour. Exp Path., 13, 1932, 473-479; Rous, Jour. Exp. Med., 15, 1911, 397-411.

6. Molitor gingivalis spec. nor. From Latin gingira, gum.

Common name: Rabbit oral-papilloma-

Hosts. LEPORIDAE-Oryclologus cuniculus (L.), domestic rabbit. Experimentally, also Lepus americanus Rods: 1.0 by 1.0 to 3.0 microns, occurring singly and in pairs. Motile with one to five polar flagella. Gram-negative. Gelatin colonies: Circular, white with

buff center, convex, smooth, undulate.

Gelatin stab: No liquefaction.

Agar colonies: Circular or amoeboid, white to buff, flat to convex, smooth, entire.

Agar slant: Filiform, pale buff, raised, smooth, undulate.

Broth: Turbid.

Nitrites not produced from nitrates. Starch not hydrolyzed.

No acid in carbohydrate media.

Attack phenol and m-cresol.

Aerobic, facultative.

Optimum temperature 30 to 35°C.

Habitat : Soil.

42. Pseudomonas rugosa (Wright). Chester. (Bacillus rugosus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 438; not Bacillus rugosus Henrici, Arb. Bakt. Inst. Tech Hochsch. Karlsruhe, I, 1892, 28; not Bacillus rugosus Chester, Determinative Bacteriology, 1901, 220, Chester, Determinative Bacteriology, 1901, 323.) From Latin, rugosus, wrinkled. Small rods, with rounded ends. occur-

ring singly, in pairs and in chains. Motile, possessing one to four polar flagella.

Gram-negative.

Gelatin colonies: Grayish, translucent, slightly raised, irregular, sinuous, radiately erose to entire

Gelatin stab: Dense, grayısh-green, limited, wrinkled, reticulate surface growth. No liquefaction.

Agar slant: Grayish-white, limited, slightly wrinkled, translucent.

Broth: Turbid, with grayish pellicle and sediment.

Litmus milk: Acid, coagulated.

Potato: Moist, glistening, brown. Indole is formed.

Nitrites not produced from nitrates.

Aerobic.

Optimum temperature 30°C.

Habitat: Water.

43. Pseudomonas desmolyticum Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 90; Achromobacter desmolyticum Bergey et al., Manual, 3rd ed., 1930, 217.) From Greek desmos, bond, band; lytikos, able to dissolve.

Rods: 0.7 to 0.8 by 2.0 to 3.0 microns, occurring singly and in pairs. Motile, with one to five polar flagella. Gramnegative.

Gelatin colonies: Circular, gray to buff, raised or umbonate. Smooth, glistening, entire.

Gelatin stab: No liquefaction.

Agar colonies: Circular or amoeboid, whitish, flat or convex, smooth, translucent to opaque, entire.

Agar slant: Filiform, pale buff, raised, smooth, undulate.

Broth: Turbid.

Nitrites produced from nitrates. Starch not hydrolyzed.

Starch not hydrolyzed Acid from glucose.

Attack phenol and naphthalene.

Aerobic, facultative. Optimum temperature 25°C.

Optimum temperature 25°C. Habitat: Soil.

44. Pseudomonas rathonis Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1923, 90; Achromobacter rathonis Bergey et al., Manual, 3rd ed., 1930, 216.) From M. L. of Ratho Park (Edinburgh).

Small rods: 0.5 to 1.0 by 1.0 to 3.0 microns. Motile, with polar flagella. Gram-negative.

Gelatin colonies: Circular, white, raised, smooth, glistening, undulate.

Gelatin stab: No liquefaction.

Agar colonies: Circular, buff, flat,

smooth, glistening, entire.

Agar slant: Filiform, pale buff, convex,

smooth, glistening, undulate.

Broth: Turbid, with pellicle. Nitrites produced from nitrates.

Starch hydrolyzed.

Acid from glucose and glycerol.

Other properties: Infectious particle has sedimentation constant  $S_{20} = ca.250$  × 10-7 cm per see, per dyne; usually there is a secondary boundary at about 375 × 10-7. Isoelectric point between pH 4.8 and 5 1. Maximum absorption at about 2750 Å. Contains thymus nucleic acid about 6.8 to 8.7 per cent; maximum absorption of nucleic acid at about 230 Å.

Literature · Beard et al., Jour. Inf. Dis. 65, 1939, 43-52, 69, 1941, 173-192, Bryan and Beard, 161d., 65, 1939. 306-321, Friedenald, Jour. Exp. Med , 75, 1912, 197-220, Hoyle, Jour. Path, and Bact .. 50, 1940, 169-170, Kidd, Jour. Exp. Med., 68, 1938, 703-724, 725-759, 70, 1939, 583-601.71, 1910, 469-491, 74, 1911, 321-344, 75, 1912, 7-20; Kidd and Rous, abid., 68, 1938, 529-562, 71, 1910, 813-838, Kidd et al., toid., 64, 1936, 63-77, 79-96, Rous and Beard, ibid , 60, 1934, 701-722, 62, 1935, 523-518; Rous and Kidd, abid., 67, 1938. 399-428, 71, 1940, 787-812; Rous et al . abid . 64, 1936, 385-400, 401-421, Schlesinger and Andrewes, Jour. Hyg., 57, 1937, 521-526, Shwp et al., Proc. Soc. Exp Biol and Med , 59, 1912, 205-207, Shope, Jour Lap Med., 58, 1933, 607-621. 65, 1937, 219-231, Syverton et al., ibid , 75, 1941, 243-218, Taylor et al., Jour Inf Dis , 71, 1912, 110-114.

8 Molitor myromae (Ameso) comb. nor. (Chiamidozoon myzomae Aragão, -Brazil Med . 25, 1911, 471, name later abandoned by its original author in favor of Strongylopiasma myzomae Aragão, Mem Inst. Oswaldo Cruz, 20, 1927, 231 and 213 The name Sanarellia cunicula Lipschütz, Wien klin, Wochenschr., 40, 1927, 1103, was bestd on the supposed cau-ative organism, defined as varying in rise between the rise of chlamydozon and of large coces, it is not clear whether the structures observed and named were virus particles or not ) From New Latin myzoma, a kind of rolt tumor, from nature of induced brains

Common names: Myxoma sirus, rirus razonatosum

Hosts: LEPORIDAE—Oryclolagus cuniculus (L.), domestic rabbit. Experimentally, also Sylvilagus sp., cottontail rabbit; jack rabbit (once in many trals), Lepus braviliensis (resistant and rarely infected). Also chick embryo and duck embryo.

Insusceptible species: Lepus californeus Gray, black-tailed jack rabbit; L. americanus Ervleben, varying hare; Spivilagus transilionalis Bangs, cottontail; horse, sheep, goat, cattle, dog (but one reported infected), gunca pig, rat, mouse, foul, pigeon, duck, cat, hainster, monkey; man (but some conjunctival pain and swelling).

Geographical distribution: South America (Brazil, Uruguay, Argentina), United States (California).

Induced disease: In domestic rabbit, a disease (muzomolosis cuniculi) almost always fatal at ordinary room temperatures but not at 36 to 42° C, lessons fewer and regressing after 6 to 8 days at these higher temperatures in most animals. At ordinary temperatures, nodules (edematous tumors) in skin near eyes, noce, mouth, ears, and genitalia; edema of evelida; conjunctivitis with purulent discharge if skin around eyes is involved. Later marked dyspaca, stertorous breatlane, cyanosis, asphyxia. Animals usually die within 1 to 2 weeks of infection. Virus enters bloodstream and invades persons system at random through walls of blood vessels. Discharges from nose, eves, and the serous exudates from affected tissues are infectious, urine and feces are not. There are evigolasmic inclusions in affeeted endermal cells. In chick embryo, experimentally, intense inflammation, eventual impairment of circulation and necrosis locally, growth best if embryo is grown at 33 to 35° C and chilled to 25° C for 12 to 18 hours before or after inoculation, lesions being linear and assoerated with capillaries in ectoderm; virus infects and is recoverable from embran and depresses hatch.

Transmission. By contact with dis-

by them. Through air for a few inches. Rarely by feeding. Experimentally, by rubbing conjunctiva with a bit of infected tissue or with a platinum loop contaminated from diseased conjunctiva; has been recovered from flies. By injection. By flea, Ctenopsylla felts (PULICIDAE), rarely.

Scrological relationships: An attack of the disease induces the formation of neutralizing antibodies. Cross neutralization by antisers to mynoma and fibroms strains. Complement is fixed with mynoma virus as test antigen in the presence of antisers to mynoma or fibroms strains. Sertum of rabbit inoculated with a colubble antigen, a heat-labile protein with societive point near pH 4.5, agglutinates mynoma elementary bodies. A second soluble antigen, also heat labile, appears distinct, inhibiting its own antibody even after imactivation of its precipitating power by exposure at 50° C

Immnological relationships: My comarecovered domestic rabbits become immune to reinfection, fibroma-strain-recovered animals, although partially immunized, still support myxoma-strain virus introduced into the testicle. Heatmactivated virus (60° C for 30 minutes) tends to immunize if given intradermally, there is then an allergia local response, less severe generalized disease, delayed death or recovery. If fibroma virus precedes myxoma virus by 48 to 96 hours, there is marked protection.

Thermal inactivation - At 55° C in 10 minutes, at 50° C in I hour A substance thermostabile for 30 minutes at 60 to 75° C, but not at 90° C, is itself unable to produce myvomatous changes after the heat treatment but may do so in combination with fibroma virus, and transistible myxoma virus is then reconstituted. Although it is supposed by some that this indicates the transformation of fibroma-strain virus into myxoma-strain virus, the possibility that heat-modified myxoma-strain virus is reactivated has not been eliminated.

Filterability: Passes Berkefeld V and N filters; not Chamberland L<sub>6</sub> or L<sub>7</sub> filters.

Other properties: Inactivated above pH 12.0 and below pH 4.0. Withstands drying. Viable at least 3 months at 8 to 10° C.

Literature: Aragão, Brazil-med., 25. 1911, 471; Mem. Inst. Oswaldo Cruz, 20. 1927, 225-235; Berry and Dedrick, Jour. Baet., \$1, 1936, 50-51 (Abst.); Berry and Lichty, 15td., 31, 1936, 49-50 (Abst.); Berry et al., Second International Congress for Microbiology, Report of Proceedings, London, 1936, 96 (Abst.); Fisk and Kessel, Proc. Soc. Exp. Biol. and Med , 29, 1931, 9-11; Gardner and Hyde, Jour. Inf. Dis., 71, 1942, 47-49; Hobbs, Am. Jour. Hyg., 8, 1928, 800-839; Science, 73, 1931, 94-95; Hoffstadt and Omundson, Jour. Inf. Dis., 68, 1941, 207-212; Hoffstadt and Pilcher, Jour. Bact., 35, 1938. 353-367, 39, 1940, 40-41; Jone, Inf. Dis., 64, 1939, 208-216; 65, 1939, 103-112; Hoffstadt et al., ibid., 68, 1941, 213-219; K. E. Hyde, Am Jour. Hyg., 23, 1936, 278-297; R. R. Hyde abid., 50 (B), 1939, 37-48, 47-55; Hyde and Gardner, ibid., 17, 1933, 446-465; 50, (B), 1939, 57-63; Kessel et al., Proc. Soc. Exp. Biol. and Med., 28, 1931, 413-414; Lipschütz, Wien, klin, Wchschr., 40, 1927, 1101-1103; Lush, Austral, Jour. Exp. Biol, and Med Sci., 15, 1937, 131-139; 17, 1939, 85-88; Martin, Austral. Counc. Sci. and Indust. Res., Bull. 96, 1936, 28 pages; Moses, Mem. Inst. Oswaldo Cruz, S, 1911, 46-53, Parker and Thompson, Jour. Exp. Med., 75, 1942, 567-573; Plotz, Compt rend. Soc. Biol., Paris, 109, 1932, 1327-1329; Rivers, Jour. Exp. Med., 51, 1930, 965-976; Rivers and Ward, ibid., 66, 1937, 1-14; Rivers et al., ibid., 69, 1939, 31-48; Sanarelli, Cent. f. Bakt., I Abt., 25, 1898, 865-873; Shaffer, Am. Jour. Hyg., 54 (B), 1941, 102-120; Shope, Jour. Exp Med., 56, 1932, 803-822; Smadel et al., ibid., 72, 1940, 129-138; Splendore, Cent. f. Bakt., I Abt., Orig., 48, 1909, 300-301; Stewart, Am. Jour. Cancer, 15 Suppl.,

1931, 2013-2028; Swan, Austral. Jour. Exp. Biol. and Med. Sci., 19, 1941, 113-115.

Strains and substrains: A strain from cottontail rabbits (Subulgous sp.), differing from typical myxoma virus, has been studied extensively under the name fibroma virus. This strain in turn is recocnized as consisting of variants and has been investigated as typical (OA) and inflammatory (IA) substrains, antigenically alike but the latter tending to peneralize in domestic rabbits. Fibroma virus is not lethal in domestic rabbits as the type strain almost always is: it appears to lack some antigenic constituents, inducing the formation of acclutining that give cross reactions with the type but of neutralizing and complementfixing antibodies that do not. The fibroma strain does not generally appear in the blood stream, as myxoma virus does, and is not contagions, at least it does not apread apontaneously among domestic rabbits as the mysoma strain does; the manner of its spread in wild rabbits in nature is not known. Its particle size has been calculated as 126 to 141 millimicrons by centrifugation, 125 to 175 millimicrons by filtration. (Ahlström, Jour. Path, and Bact., 46, 1938, 461-472; Andrewes, Jour, Exp. Med., 63 1936, 157-172; Hoffstadt and Pilcher, Jour. Inf. Dis., 68, 1941, 67-72; Hurst. Brit. Jour. Exp. Path., 18, 1937, 1-30; Austral, Jour. Exp. Biol. and Med. Sci., 18, 193S, 53-64, 205-208; Hvde, Am. Jour. Hyg., 24, 1936, 217-226; Ledingham, Brit, Jour. Exp Path., 18, 1937, 436-449; van Rooven, ibid., 19, 1938, 156-163; van Rooven and Rhodes, Cent. f. Bakt., I Abt., Orig , 142, 1938, 149-153; Schlesinger and Andrewes, Jour, Hyg., 57, 1937, 521-526; Shope, Jour. Exp. Med , 56, 1932, 793-822, 68, 1936, 33-41, 43-57, 173-178.

## FAMILY III. ERRONACEAE FAM. NOV.

Viruses of the Encephalitis Group, inducing diseases mainly characterized by effects on nerve tissues.

Key to the genera of Samily Erronaceae.

I. Viruses of the Typical Encephalitis Group.

Genus I. Erro, p. 1248.

II. Viruses of the Poliomyelitis Group

Cenus II. Legio, p. 1257.

III. Viruses of the Rabies Group. Genus III. Formido, p. 1283.

Genus III. Formiao, p. 1263.

# Genus I. Erro gen. nov.

Viruses of the Typical Encephalitis Group, inducing diseases mainly characterized by injuries to cells of the brain. Vectors of some known to be ticks; dipterous insects Let also transmit. Generic name from Latin erro, a vagrant.

The type species is Erro scatteus spec. nov.

## Key to the species of genus Erro.

- I. Affecting sheep principally, but also man.
  - 1. Erro ecoticus.
- II. Affecting man principally.
- Erro silvestris
- 3. Erro incognitus.
- 4. Erro japonicus.
- 5. Erro neli.
  6. Erro scelestus.
- III. Affecting horse principally, but also man.
  - 7. Erro couinus.
- IV. Affecting horse, cow, sheep.
- 8. Erro bornensis.

1. Erro scoticus spec. nov. From Latin Scoticus, Scottish.

Common name Louping-ill virus.
Hosts: HOVIDAE—Ons ares L.,
sheep. HOMINIDAE—Home septems
L., man. Experimentally, also mouse,
rat (subclinical infection), chick embrya
(discrete primary lesions on choroallio
tie membrane), Macacus rhesus, horse,

cow, pig.
Insusceptible species: Guinea pig,
rabbit.

Geographical distribution: Scotland, northern England.

Induced disease In sheep, encephalitis charactérized by duliness followed by incoordination of movement, frequently with tremors chiefly of the head, saliva-

tion, champing of paws; pro ration, coma, In man, ence halitis with death. prompt and complete re overy accompanied by formation of sperific neutralizing antibodies. In mone, experimentally, diffuse encephalom, elitis with mild meningeal involvement, following intracerebral inoculation, fine rhythmical tremor involving neck, nose, and ears, unsteadiness, muscle spasms, respiratory distress, sometimes clonic and rarely tonic convulsions: hind limb paralysis, dribbling of urine, resention of spontageous limb movements, death; in mouse inoculated intraperitoneally, virus usually enters central nervous system by way of the olfactory mucosa and olfactory bulb, occasionally by trauma at points of

damage: in mouse inoculated intranasally, views enters blood and reaches the olfactory bulb where it multiplies to a high concentration before infecting the remainder of the brase and the rest of the pervous system, tends to disappear from the blood after sickness begins but persists in the brain until death from encephalitis. In chick embryo, after inoculation of choricallantoic membrane, edems and opacity spreading from site of ineculation on membrane of 10-day embryo, in 12-day eggs, discrete primary lesions, sometimes with secondary lesions surrounding them on the inoculated membrane, embryo dies in about 6 days, after showing jaundice, edema, mottling of the liver with necrosis; virus regularly in blood. In monkey, Macacus thesus, progressive cerebellar ataxia: encephalomyelitis with involvement and massive destruction of Purkinje cells in the cerebellum.

Transmission: By ticks, Rhipscepholus appendiculation and Isode rennant (IAO-DIDAE) In Rhipscepholus appendiculation, the larva or symph becomes infected, only a few individuals retain virus until the adult stage, virus does not pass through the egg. Non-tiruliferous tecks do not acquire virus by feeding with infective ticks on immune animals Experimentally, by intracerebral or intra-particular injection in move, by intransa instillation in rat, mouse, and monkey.

Serological relationships Complements, fivation and neutralization tests show cross reactions with Russian spring-summer encephalitis virus, but immune serum against louping ill virus is only partially effective in neutralizing the spring aummer encephalitis virus.

Immunological relationships Mice are potential against louping-ill virus by saccination with non-vicinelat spring-summer encephalitis virus but profestion is less effective than for the homologous virus. No cross immunity with respect to Ruft Valley fever virus of Macagas rateus, but immunity virus in Macagas rateus, but immunity virus in Macagas rateus, but immunity.

with respect to reinfection by louping-ill virus has been demonstrated.

Thermal inactivation: At 58° C in 10 minutes.

Filterability: Passes Berkefeld V, N, and W filters.

Other properties: Viable in broth filtrates after storage at 4° C and pH 7.6 to 8.5 for 70 days. Particle diameter, calculated from ultrafiltration data, 15 to 20 millimicrous.

Literature: Alexander and Neitz, Vet. Jour., 89, 1933, 320-323; Onderstepoort Jour. Vet. Sci. and Anim. Industr., 5. 1935. 15-33; Alston and Gibson, Brit, Jour. Exp. Path., 12, 1931, 82-88; Burnet. Jour. Path, and Bact., 42, 1936, 213-225; Brit, Jour. Exp. Path., 17, 1936, 294-301 Burnet and Lush, Austral, Jour. Evo. Biol. and Med. Sci., 16, 1938, 233-240; Casals and Webster, Science, 97, 1913. 246-248; Jour. Exp. Med., 79, 1944, 45-63, Elford and Gallonay, Jour. Path. and Bact . 57, 1933, 381-392; Findlay. Brit, Jour. Exp. Path., 13, 1932, 230-236; Fite and Webster, Proc. Soc. Exp. Biol. and Med., 31, 1931, 695-698; Gallonay and Perdrau, Jour. Hyg., 55, 1935, 339-346; Hurst, Jour Comp. Path, and Therap., 44, 1931, 231-245, M Tadvenn. Jour. Comp. Path, and Therap., 7, 1891. 207-219. 13, 1900, 145-154; Pool et al. thid , 45, 1930, 253-200, Rivers and Schwentker, Jour. Exp. Med., 59, 1934, 609-655, Schnentker et al., ibid., 67. 1933, 955-965.

2. Erro allestris spec. nor. From Latin ultratris, of the forest, in reference to incidence of the induced disease almost exclusively in those who enter forest lands.

Common names. Spring summer encephalitis virus, forest spring encephalitis virus.

Hests Man; probably cattle, horse; Evanues ancheve orienfelts, Encloying rufocanus arsenjes. Lajectmentaly, also white mouse, Macneus thesus, birds, goat, sheep, Microtus ruchnos pelliceus Thom., Crestulus furunctus. Geographical distribution: Union of Soviet Socialist Republics.

Induced disease: In man, acute nonsuppurative encephalitis, abrupt onset, steep rise of temperature to 28 to 40°C, severe headache, giddinese, and vomiting; parcese and paralyses of upper or lower limbs or muscles of neck and back; residual atrophic paralyses common; mortality among cases, 30 per cent; 80 per cent of all cases occur in May and June.

Transmission By tick, Izodes persulcatus (IXODIDAE); the virus seems to hibernate in this species and has proved capable of passing through eggs to progeny. Experimentally, also by ticks Dermacentor silvarum and Haemaphysalis concinna (IXODIDAE).

Serological relationships: Virus-neutralizing antibodies, found without other evidence of disease in some men and in many cattle and horses, believed to indicate susceptibility of these hosts to latent infections. No cross neutralization with St. Louis encephalitis virus, Japanese summer encephalitis virus is in part antigenically related, but some antigenic constituents of this virus are missing in spring-summer encephalitis virus and price versa.

Immunological relationships: Formolized virus immunizes specifically.

Filterability: Passes Berkefeld and Chamberland filter candles.

Literature Smorodintseff, Arch. f. gesamt. Virusforsch., 1, 1940, 463-489; Soloviev, Acta Med. U. R. S. S., 1, 193S, 484-492 (Biol. Abst., 17, 1943, 1726, no. 18777).

 Erro incognitus spec. noc. From Latin incognitus, unknown, in reference to mystery surrounding the nature and relationships of this virus, as evidenced by common name.

Common name · Australian X-disease

Hosts . HOMINIDAE—Homo saprens L., man. Experimentally, also sheep, horse, cow, rhesus monkey. Geographical distribution · Australia.

Induced disease: In man, policencephalitis, especially in children, occurring in late summer; mortality high; characterized by headache, body pains, drowsiness, weakness, then vomiting, fever, convulsions; paralysis of limbs, eyemuseles, or face rate; recovery rapid in pon-fatal cases.

Literature: Kneebone, Austral. Jour. Exp. Biol. and Med. Sci., 3, 1926, 119-127; Perdrau, Jour. Path. and Bact., 42, 1936, 59-65.

 Erro japonicus spec. nov. From New Latin Japonia, Japan.

Common name: Japanese B encepha-

Hosts: HOMINIDAE—Homo sapiens L., man. Experimentally, also young sheep, mouse, and Macacus rhesus. Congraphical distribution: Japan,

Geographical distribution: Japan Union of Soviet Socialist Republics.

Induced disease: In man, loss of appetite, drowsiness, nausea, then rapid rise of temperature, pains in joints and chest; restlessness followed by apathy, coma; death, usually before end of second week, or recovery, sometimes with persistence of evidences of damage done to the nervous system by the disease.

ous system by the disease. Serological relationships. Specific antiserum does not neutralize St. Louis encephalitis virus ol ouping-ill virus. Russian autumn-encephalitis virus induces the formation of antisera neutralizing Japanese B encephalitis virus. Bussian spring-summer encephalitis virus contains some, but not all, antigens in common with this virus. Australian X-disease virus is distinct in neutralization tests.

Inmunological relationships: Specific immunity as a result of earlier infection in mice; no cross protection with respect to St. Louis encephalitis virus. Vaccuration with Japanese B encephalitis virus does not enhance resistance to West Nile encephalitis virus but only to the homologous virus.

Thermal inactivation: At 56° C in 30

Filterability · Passes Berkefeld N, W, Chamberland L, L, and Seitz EK filters, with case

Laterature. Kudo et al., Jour Immunol., 22, 1937, 129-135; Smorodintesfe et al., Arch. f. gesamt. Virusforsch., 1, 1940, 559-559, Webster, Jour Exp Med., 57, 1938, 609-618

5. Erro nili spec ror. From I atm

G mmen name West Nile encey habits virus

Hosts HOMINIDAE—Homosopiens L., man (perhaps without inducing any definite disease) Experimentally, also riceus number meuse

Geographical distribution Africa (Ugrada)

Induced disease. In man, no details are known virus was originally isolated from blood of a woman rative of Uganda, at the time the temperature of the patient was 100 6° I' but she denied illness, moreover, two laboratory workers developed neutralizing antibodies without recognizable chairal disease. In mouse, experimentalls, after intracerebral inoculation, incubation period to 4 or 5 days, then hyperactivity and roughening of coat; later, weakness, hunched attitude, sometimes paralysis of hind quarters, usually come before death. In theses monkey, experimentally, after intracerebral or intranasal inoculation, fever and encontralities

Sembagnal relationships Nocross reactions in complement fixation tests between the and enume encephalitis virus, Japanese B encephalitis virus, St. Louis encephalitis virus, or lymphocytic choromeningitis virus. Neutralization tests show some common antigens in West Nile encephalitis virus, Japanese B encephalitis virus, Japanese B encephalitis virus, anticerum to West Nile virus does set i cuterfilire either of the others but anticers against St. Louis virus may neutralize West Nile virus and anticers. against Japanese B virus have some effectiveness in neutralizing both West Nile time and St. Louis times.

Immunological relationships: Vaccination with this virus does not enhance resistance to Japanese B or St. Louis encephalisis viruses but only resistance to the homologous virus.

Thermal mactivation. At 55° C, not at 50° C, in 30 minutes.

Filterability Passes Berkefeld V, N, and W filter candles readily; also passes Seitz EK asbestos pads and collodion membranes 79, not 62, millimicrons in average pure diagreter.

Other preperties Infective particle 21 to 31 millimerons in diameter, as calculated from filtration experiments. Value at least 2 weeks at 2 to 4° C. Viable after drying from the frozen state.

Literature Havena et al , Jour. Exp. Med., 77, 1913, 139-163, Smithburn, Jour. Immunol., 44, 1912, 25-31, Smithburn et al, Am Jour. Trop. Med., 80, 1910, 471-492.

6. Erro scelestus spec not. From Latin scelestus, infamous

Common name St. Louis encephalitis virus.

Hosts HOMINIDAE-Homo capiens L. man A great number of mammals and birds in endemic areas may have antisera that neutralize the virus, indicating that they are probably natural hosts, among these are ANATIDAE-Anas platurhuncha L . Mallard and Pokin ducks, Anser anser (L ), domestic gaose BOVIDAE-Bos taurus L., cow., Capra hireus L., goat, Our aries L., sheen, CANIDAE-Canis familiaris L., dog COLUMBIDAE - Columbalura, domestic piccon. Zenaidura macroura, nextern mourning dove. EOUIDAE-Ecuts eaballus L., horse, FALCONIDAE-Falco sparrerius L., sparrow hank LE. PORIDAE-Lepus caldornicus Gray. tack rabbat, Sylerlagus nuttelli, cottontail rabbit. MELEAGRIDAE-Meleagris golloparo L., turkey. MURIDAE -Rattus norregieus (Berkenhout), bronn

nat. MUSCICAPIDAE—Turdus migratorius I., robin. PHASIANIDAE—Gallus gallus (I.), chicken; Laphartyz californica, California quail. PICIDAE—Asyndeemus levis, Lewis woodpecker; Colaptes cafer (Gm.), red-shafted flicker. STRIGIDAE—Bubo virginianus (Gm.), great horned owl. SUIDAE—Susserofa Li., pig. Experimentally, white mouse (some substrains of the Swiss white mouse are genetically more readily infected than others); Nacacus thesus; pigeon (inapparent infection); chick embryo and to a limited extent the young hatched chek.

Insusceptible species: Laboratory rabbit, Cabia monkey, guinea pig, rat.

Geographical distribution: United

Induced disease In man, during summer and fall, about 9 to 21 days after exposure, headache, high fever, rigidity of neck, tremors, encenhalitis, usually with fever: some patients become drowsy. others sleepless or delirious; usual sequelae headaches, irritability, some loss of memory, and drowsiness; neutralizing antibodies maintained in vito at least 21 years after occurrence of disease. Experimentally, in susceptible strains of white mouse inoculated by intracerebral intection, after 3 to 4 days, coarse tremors, convulsions, prostration, death; perivascular accumulations of mononuclear leucoeytes throughout brain, stem, cord, and pia, with destruction of pyramidal cells in the lobus piriformis and corne Ammonts, subcutaneous and intraperitoneal injections immunize against subsequent infection by intracerebral inoculation, virus reaching only blood and spleen in the process of immunization unless an excessive dose is given, some substrains of the White Swiss mouse are relatively resistant to infection, requiring inoculation with about 1000 times the minimal infective dose for highly susceptible strains and wien infected proving relatively poor sources of virus for submoculation; highly susceptible substrains of the White Swiss mouse lack a single

major, dominant, genetic factor that is present in resistant substrains.

Transmission. By meaquito, Culez tarsalis Coquillett (CULICIDAE), probably extensively; this insect has been collected in nature carrying the virus. Experimentally, by larvae of America dog tick, Dermacentor variabilis (Say) (IXODIDAE); by mosquito, Culexpipiens Lina., var. pallans Coq. (Cult. CIDAE). To mice, by feeding on infected tissues

Serological relationships: Human antisern may neutralize virus after clinical and subclinical attacks.

Immunological relationships: Specific intraccrebral immunity after vaccination by subcutancous or intraperatoneal injection in mice appears early (about I neek after vaccination) and disappears before humoral antibody titer reaches its maximum.

Thermal inactivation: At 56° C in 30 minutes.

Filterability: Passes Berkefeld V and N filter candles and collodion membranes 66 millimitrons in average pore diameter.

Other properties: Storage in human brain tissee in glycerine martivates this virus in about 32 days. Diameter of infective particle calculated from filtration data as about 20 to 35 millimicross. In storage, rabbit and abeep sera act to some extent as preservatives. At 4° C, after drying in racca while frozen, viable in apparently undaminished titer for at least 17 months.

Literature: Barg and Reeves, Jour.
Inf. Dis., 70, 1942, 273-274; Bauer et al.,
Proc. Soc. Exp. Biol. and Med., 51, 1934,
696-699, Blattner and Cooke, Jour. Inf.
Dis., 70, 1942, 226-230; Blattner and
Heys, Proc. Soc. Exp. Biol. and Med.,
48, 1941, 707-710; Cook, Jour. Inf. Dis.,
68, 1938, 260-246; Cook and Hudson,
ibid., 61, 1937, 289-292; Elford and
Perdenu, Jour. Path. and Bact., 40, 1935,
143-146; Harmson and Howitt. Am. Jour.
Hyr., 35, 1942, 163-185, Harmson et al.,
Science, 94, 1941, 305-307, 325-330, Jour.
Inf. Dis., 70, 1942, 263-266, 267-272, 278-

283: Harford and Bronfenbrenner, Jour. Inf. Dis., 70, 1942, 62-68; Harrison and Moore, Am. Jour. Path., 13, 1937, 361-275; Hodes, Jour. Exp. Med., 69, 1939, 533-513: Hodes and Webster, 161d., 68, 1938, 263-271; Lennette and Smith, Jour. Inf. Dis . 65, 1935, 252-254; Mitamura et el., Trans Soc. Path. Jap., 27, 1937, 573-550: Muckenfuss et al., U. S. Pub. Health Service, Public Health Rept., 48, 1933, 1311-1313, O'Leary et al., Jour. Exp. Med., 75, 1942, 233-246; Reeves et al , Proc. Soc. Exp Biol. and Med , 60, 1942, 125-128, Sulkin et al., Jour, Inf. Dis., 67. 1910, 252-257; Webster, Jour, Exp Med., 65, 1937, 261-286; 68, 1938, 111-124; Webster and Clow, shid., 63, 1936, 433-448. 827-815; Webster and Tite, ibid, 61, 1935, 103-114, 411-422; Webster and Johnson, 1614, 74, 1911, 489-494, Webster et al., 61, 1935, 479-487; 62, 1935, 827-817.

7. Erro equinus spec, nor. From Latin equinus, pertaining to horses. Common name. Equine encephalities

Hosts. EQUIDAE-Equus caballus L . horse: I hybrid of the horse and E asinus L., mule. HOMINIDAE-Homo saviens L., man. COLUMBIDAE-Columba liria, domestic pigeon PIIA-SIAAIDAE-ring-pecked pheasant. TETRAONIDAE-Tympanuchus cupido L. vat americanus (Reichenbach). prairie chicken Many additional speeres have been found to show neutralizing antisers at times and these are presumably natural hosts of the virus upon occagion, among them are ANATIDAE-Anas platyrhyncha L., Mallard and Pekin ducks, Anser anser (L.), domestic coore BOVIDAE-Postaurus L. cow. Carra hireus L., goat , Oris aries L., sheep. CANIDAE-Canis Jamiliaris 1., dog. CHARADRIIDAE-Oxyrchus rociferus 1. Addeer CRICETIDAE-Microtus montanus (Peale), field mouse, Peromuseur maniculatus (Wagner), white footed mouse FALCONIDAE-Falco sparterrus L. sporrow hawk. MELEAGRI-DAE-Meleagris galloparo L., turkey.

MURIDAL-Rattus rattus L., black rat. MUSCICAPIDAE-Turdus migratorius L., robin. MUSTELIDAE-Mustela frenata Lichtenstein, weasel, PHASIANIDAE-Gallus callus (L.). chicken: Lophortuz californica, California quail : Phasianus colchicus L., ringnecked pheasant. PICIDAE-Colonics cafer (Gm.), red-shafted flicker. STRI-GIDAE-Bubo virginianus (Gm.), creat horned owl. SUIDAE-Sus scrofa L. mg. Experimentally, also chick embryo. coose embryo, pheasant embryo, robin embryo, pigeon embryo, turkey embryo, sparrow embryo, duck embryo, and guinea-fowl embryo; white mouse, guinea nic, rabbit, piccon, white rat, calf, sheen, monkey, goat, dog, hen, turkey; Zonotrichia leucophrys gambeli, Gambel sparrow: Passer domesticus L., English sparrow: Lophortuz californica, quail: Junco orceanus, junco: Toxostoma leconter lecontei, throsher : Citellus richardsonii (Sabine), gopher or Richardson's ground souirrel: Sigmodon hispidus Say and Ord. cotton rat; Dipodomys heermanni Le Conte. kangaroo rat: Resthrodontomus megalatus, wild mouse: Microtus montanus, M californieus and M. mordaz, wild mice . Peromyseus maniculatus (Wagner), white footed mouse; Neotoma fuscipes Baird, wood rat: Sulvilague bachman: (Waterhouse), brush rabbit; S. audubents (Baird), cottontail rabbit: Canis familiaris L , dog (puppies); Anser cinereus, goose: Anas boscas L., duck: Circus rufus (Cm.), hank: Turdus merula L., blackbird, Ciconia ciconia L., white stork . Pullur foleus Briss .. tawny vulture: Marmola monax (1..), woodchuck, Microtus pennsulconicus (Ord.). feld vole; Spectyto cuntcularia hupuanea (Bonaparte), western burrowing owl; Molothrus oter (Boddaert), conbird; common qual or bob white Insusceptible species: I'mg (cat and

onesum reported as "refractors"). Geographical distribution: United States, Canada, Argentina,

Induced disease : In horse, initial fever, then signs of fatigue, commolence; ocea-

sional excitability followed by incordinated action of limbs, disturbed equilibrium, grinding of teeth, paresis and varied paralyses; frequently inability to swallow, paralysis of line and bladder, amaurosis; case fatality about 50 per cent; recovery without sequelac in mild cases: death within 3 to 8 days in severe cases. In man (children particularly vulnerable), a profound, acute, disseminate and focal encephalomyelitis characterized by intense vascular engorgement, perivascular and parenchymatous cellular infiltration and extreme degenerative changes in the nerve cells. In chick embryo, excessive increase of virus continuing until just before host's death, virus being found eventually throughout the egg but most concentrated in the embryo; vaccines made from virus grown in chick embryo and then inactivated are especially effective because of the high titer of virus represented in them; increased resistance with age characteristic of choricalizatoic membrane as well as of batched chick; rounded acidophilic masses occur usually near periphery of nucleus in embryonic nerve cells; no such inclusions are found as a result of infection with Borna disease virus or poliomyelitis virus.

Transmission . Experimentally by tick, Dermacentor andersons Stiles (IXODI-DAE), passing through eggs to offspring; this tick is infective to susceptible animals on which it feeds as larva, nymph or adult. Experimentally by Aèdes acgupti L. (to guinea pig and horse, preinfective period 4 to 5 days; insects retain virus for duration of life, not to eggs of infected mosquitoes; not passed from males to females or by males from female to female), A. albonicius, A. atropalpus, A. cantator, A. dorsalis, A. nigromaculis, A. sollicitans, A. taensorhynchus, A. trisersatus, and A. rezans (CULICIDAE). Triatoma sanguisuga (Le Conte) (RE-DUVIIDAE) has been found infected in nature and has transmitted virus experimentally to guinea pigs. The Ameriean dog tick, Dermacentor variabilis Say (IXODIDAE) has been infected by

inoculation, not by feeding; it has not been shown to transmit.

Serological relationships: Neutralizing antibodies are formed as a result of vaccination with inactive, formolized virus; antigenicity of formalin-inactivated virus as well as of active virus is blocked in the presence of antiserum. In rabbit, cerebral resistance is coincident with presence of neutralizing antibody in spinal fluid. In guinea pig, therapy with specific antiserum ineffective if begun after onset of encephalitis; effective if begun within 24 to 48 hours of peripheral inoculation. No cross neutralization reaction with lymphocytic choriomeningitis virus. Japanese B encephalitis virus or St. Louis encephalitis virus. Constituent strains (typical Western and Eastern) do not give cross neutralization reactions, but do show the presence of common antigens by cross reactions in complement fixation not shared with such other viruses as Japanese B encephalitis virus, St. Louis encephalitis virus, West Nile encephalitis virus, lymphocytic choriomeningitis virus. Sera of human cases may be negative by complement firation tests a few days after onset, yet strongly strain-

specific during second week of illness. Immunological relationships: Young of immunized guinea pigs are immune to homologous strain at least a month after birth. No cross immunity between Western and Eastern strains of equine

encephalitis virus.
Thermal inactivation · At 60° C, not at

56° C, in 10 minutes.
Filterability: Passes collodion membranes 66, not 60, millimicrons in average pore diameter. Passes Berkefeld V, N, and W, finest Mandler, and Seitz filters.

Other properties: Inactivated below pH 55. Visible at least a year, dry in vacuum. Particle diameter estimated from filtration experiments to be 20 to 30 millimierons. Electron micrographs show particles as spherical or disk-shaped, about 39 millimierons in diameter with round or oval region of high density within each, older preparations show

Attack phenol and cresol at times, also naphthalene.

Aerobic, facultative.
Optimum temperature 25°C.
Habitat: Manure and soil.

 Pseudomonas dacunhae Gray and Thornton. (Gray and Thornton, Cent. I. Bakt., II. Abt., 78, 1928, 90; Achromobacter dacunhae Bergey et al., Manusi, 3rd ed., 1930, 217.) From M. L. from the Island of d'Acunha.

Rods: 0.5 to 0.8 by 1.5 to 3.0 microns. Motile with one to six polar flagella Gram-negative.

Gelatin colonies: Circular, whitish,

Gelatin stab: No liquefaction.

Agar colonies: Circular to amoebold, white, flat, glistening, opaque, entire Agar slant; Filiform, pale buff, raised,

smooth, glistening, undulate Broth: Turbid.

Dioin: Intola.

Nitrites produced from nitrates. Starch not hydrolyzed.

No acid from carbohydrate media Attack phenol.

Aerobie, facultative. Optimum temperature 25°C. Habitat: Soil.

46. Pseudomonas arvilla Gray and Thornton. (Gray and Thornton, Cent f. Bakt., II Abt., 73, 1928, 99; Achromobacter arvillum Bergey et al., Manual, 3rd ed., 1930, 217) From Latin, arviva, an arable field; M. L. dim. a httle field.

Rods: 0.5 to 0.7 by 2.0 to 30 microns. Motile with one to five polar flagella.

Gram-negative.

Gelatin colonies: Circular, whitish, convex, smooth, glistening, lobate

Gelatin stab: No liquefaction Agar colonies. Circular or amoeboid, white to buff, flat to convex, smooth,

glistening, opaque, entire.
. Agar slant: Filiform, whitish, concave, smooth, ringed, entire.

Broth: Turbid.

Nitrites not produced from nitrates.

Starch not hydrolyzed. Acid from glucose. Attacks naphthalene. Aerobic, facultative. Optimum temperature 25°C. Habitat: Soil.

47. Pseudomonas salopium Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1923, 91; Achromobacter salopium Bergey et al., Manual, 3rd ed., 1930, 219) From Latin, Salop, Shropshire.

Rods: 0.7 to 1.0 by 1.0 to 3.0 microns, occurring singly and in pairs. Motile with one to six polar flagella Gram-negative.

Gelatin colonies: Circular, grayishbuff, flat, rugose or ringed, translucent border

Gelatin stab. No liquefaction

Agar colonies: Circular or amoeboid, white to buff, flat to convex, smooth, glistening, translucent border, entire. Agar slant: Filiform, whitish, raised.

smooth, glistening, lobate. Broth: Turbid with pellicle.

Nitrites not produced from nitrates. Starch not hydrolyzed. Acid from glucose and sucrose

Attacks naphthalene. Aerobic, facultative.

Optimum temperature 25°C. Habitat: Soil.

48. Pseudomonas minuscula McBeth. (McBeth, Soil Science, 1, 1916, 437; Cellulomonas minuscula Bergey et al., Manual, 1st ed., 1923, 162.) From Latin dim. rather small.

Rods : 0.5 by 0.9 micron. Motile with one to two polar flagella. Gram-negative. Gelatin stab: Moderate growth. Slight napiform liquelaction.

Agar colonies: Small, circular, slightly convex, butyrous becoming brittle, grayish-white, finely granular, entire.

Agar slant: Moderate, flat, grayishwhite.

Broth: Turbid.

824; Jour. Bact., \$3, 1937, 60; Am. Jour. Hyg., 32 (B), 1940, 19-23; 33 (B), 1941, 37-41; Jour. Exp. Med., 73, 1941, 507-529; Taylor et al., Jour. Inf. Dis., 67, 1940, 59-66; 69, 1941, 224-231; 72, 1943. 31-41; TenBroeck, Arch. Path., 25, 1938, 759 (Abst.); TenBroeck and Merrill. Proc. Soc. Exp. Biol. and Med., 51, 1933, 217-220; TenBroeck et al., Jour. Exp. Med., 62, 1935, 677-685; Traub and Ten Broeck, Science, 81, 1935, 572; Tyzzer and Schlards, Am. Jour. Hyg., 53 (B), 1941, 69-81; Tyzzer et al., Science, 88, 1938, 505-506; van Roekel and Clarke, Jour. Am. Vet. Med. Assoc., 94 (N.S. 47), 1939, 466-468; Webster and Wright, Science, 88, 1938, 305-306; Wesselhoeft et al., Jour. Am. Med. Assoc., 111, 1938, 1735-1740; Wright, Am. Jour. Hyg., 36, 1942, 57-67,

 Erro bornensis spec. nov. From Borna, name of a town in Saxony where a severe epizootic occurred in 1894 to 1896.

Common name : Borna-disease virus.

younger), mouse; Macaca mulatta (Limmermann) rhesus monkey.

Insusceptible species: Ferret, cat, pigeon; probably dog.

Geographical distribution. Wurtemburg, Germany, North and South America, Hungary, Russia, Belgium, France, Italy, Roumania.

Induced disease: In horse, encephalomyelitis characterized by lassitude, indifference to external stimuli; later intermittent excitement, difficulty in mastication and deglutition, spasms in various muscles, champing, excessive salivation; pupils unequal in suc; paralysis of hindquarters, tail, muscles of tongue, or muscles of back; temperature usually normal; death in 20 to 37 hours or, less often, recovery after about 1 to 3 weeks. Virus may pass placenta and infect fetus in pregnant animals.

Transmission: To rabbit, experimentally by feeding and by injection intracerebrally, intraocularly, nasally, intravenously, subcutaneously, or intraperitoneally; not by living in same care.

Immunological relationships: No cross immunity conferred by the Western strain of equine encephalomyelitis virus. Isolate of Borna disease virus from the horse immunizes rabbits against isolate from sheep, and tree zerse. Herpes and rabies viruses do not immunize rabbits against subsequent infection by Borna disease virus.

Thermal inactivation: At 50 to 57° C in 30 minutes; at 70° C in 10 minutes.

Filterability: Passes Berkefeld N and Mandler filters, but with difficulty. Passes collodion membranes of average pore diameter 400 millimicrons readily, 200 millimicrons with difficulty, 175 millimicrons not detectibly. May be separated by differential filtration from louping-ill virus, which will pass even a 125-millimicron membrane.

Other properties: Particle size estimated from filtration data as \$5 to 125 millimicrons. Optimum pH for stability in broth at 15 to 20° C is 7.4 to 7.6; very sensitive to greater alkalinity Viable after 327 days dry at laboratory temperatures. Viable at least 6 months in 50 per cent glycerine. Inactivated by putrefaction in 5 days; by 1 per cent carbolic acid in 4, not in 2, weeks.

Literature: Barnard, Brit, Jour. Exp.
Literature: Barnard, Brit, Jour. Exp.
Path., 14, 1933, 205-206; Covell, Proc.
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Elford and Galloway, Brit, Jour. Exp.
Path., 14, 1933, 196-205; Howitt and
Meyer, Jour. Infect. Dis., 54, 1934, 364367; Nicolau and Galloway, Brit, Jour.
Exp. Path., 8, 1927, 336-311, and in
Exp. Path., 8, 1927, 336-311, and in
Exp. Path., 8, 1927, 336-311, and in
Exp. Tath., 10, 1928, 50 Pp.
Ann. Inst. Pasteur, 44, 1630, 673-605; 45,
Ann. Inst. Pasteur, 44, 1630, 673-605; 55,
Ann. 1610, 475-523, Zwick et al., Ztechr. Infektionshr. parasit. Kranhh. u. Ilye. d.
Haustiere, 50, 1926, 42-136; 55, 1927,
150-179.

comma-shaped particles. Sedimentation constant, mean 265.5 × 10<sup>-11</sup> ± 54 × 10<sup>-11</sup> (trage 232 to 276 × 10<sup>-11</sup>). Specific volume 0.861. Molecular weight of liponucleoproten complex behaving as the virus enteulated as 152 million, approximately 250 particles giving 50 per cent infection, material contains 4 per cent carbohydrate. Absorption of ultraviolet light reaches a peak at about 2000 Å, a broad minimum at about 2450 Å, and an increase at 2200 Å.

Strains The Western strain (so-called Western enunc encephalitis virus) may be considered as type of a large group of variants met in nature, some produce clinically milder disease than others (Birch, Am Jour Vet Res. 2, 1941. 221-226), they may change in virulence on passage in experimental hosts. The l'astern strain (so-called Eastern equine encephalitis virus) has been studied extensively also, and has been found to differ from the type strain especially in more ramd course of induced disease in the horse, in being experimentally transmissible to sheep, pig. dog, cat and the European hedgebog; in its localization in eastern roast states and absence from the area between Cabbornes and Wisconsin. where the type strain is found, in failure experimentally to infect Aides acquely unless moculated into body cavity by needle puneture, whereupon it persists and can be transmitted, and in failure of eross neutralization with the western strain A strain produced by serial passage in pigeons is reported to have caused no obvious reaction in horses but to have induced the formation of neutenlizing antibodies Λ Venezuelan strain differs from the type in comple ment fixation reactions, it induces in man a mild disease, characterized by malaise, fever, headache or drownness, and uneventful recovery (Casaly et al., Jour. Exp. Med , 77, 1913, 521-530)

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Serological relationships: Specific neutralizing antibodies arise after experimental infection in monkeys, but reinfection is not prevented; only a minority of human convalescent sera neutralize virus in vitro, the most potent sera probably being obtained from those with transient or light paralysis. Cross neutralization between monkey-passage and murine (cotton-rat and mouse) strains. No cross neutralization reaction with lymphocytic choriomeningitis virus. Isolates differ somewhat antigenically, homologous titers being higher than heterologous titers in some neutralization tests.

Thermal mactivation At or below 75° C in 30 minutes.

Filterability · Passes membrane about 35, not 30, millimicrons in average pore diameter.

Other properties. Infectivity of virus maintained well at -76° C or in glycerine but poorly when dried or just frozen. Inactivated readily br hydrogen peroxide. Particle diameter estimated as about 12 millimierons by filtration studies. Precipitated by half-saturated ammonium sulphate solutions. Electron micrographs show elliptical particles 20 to 30 millimierons in diameter; impure infectious materials show long threads 20 by 75 to 500 millimicrons in size. Component probably virus has sedimentation constant Suo = 62 × 10-11 cm per sec. per dyne. Inactivated by potassium hydroxide, copper sulfate and potassium permanganate. Stable from pH 2.2 to 10.4 for 2 hours at 37° C

Literature Armstrong and Harrison, U. S. Pub. Health Service, Public Health Rept., 50, 1935, 725-730, Aycock, Am. Jour. Hyg., 7, 1927, 791-803, Burnet and Jackson, Austral. Jour. Exp. Bed. and Med. Sci., 17, 1939, 261-270, 18, 1910, 361-366, Burnet et al., ibid., 17, 1839, 253-260, 375-391; Elford et af., Jour. Path, and Bact., 40, 1935, 135-141; Flex-

ner, Jour. Exp. Med., 62, 1935, 787-801; 63, 1936, 200-226; 65, 1937, 497-513; Gard. ibid., 71, 1910, 779-785; Gordon and Lennette, Jour. Inf. Dis., 64, 1939, 97-101; Harmon, ibid., 58, 1936, 331-336; Heaslip. Austral, Jour. Exp. Biol. and Med. Sci., 16, 1938, 285-286; Howitt, Jour. Inf. Dis., 51, 1932, 565-573; 63, 1933, 145-156; Hudson and Lennette, Am. Jour. Hyg., 17, 1933, 581-586; Jungeblut and Bourdillon, Jour. Am. Med. Assoc., 123, 1943, 399-402; Jungeblut and Sanders, Jour. Exp. Med., 72, 1940, 407-436; 76, 1942, 127-142, Jungeblut et al., ibid., 75, 1942, 611-629; 76, 1942, 31-51; Kessel et al., Am. Jour. Hyg., 27, 1938, 519-529; Jour, Exp. Med., 74. 1911, 601-609; Kolmer et al., Jour. Inf. Dis., 61, 1937, 63-68; Kramer et al., Jour. Exp. Med., 69, 1939, 46-67; Lennette and Hudson, Jour. Inf. Dig., 58, 1936, 10-14; Loring and Schwerdt, Jour. Exp. Med., 75, 1942, 395-406, McClure and Langmuir, Am. Jour. Hyg , 35, 1942, 285-291; Melnick, Jour. Exp. Med., 77, 1943, 195-204; Moore and Kessel, Am. Jour. Hyg., 58, 1913, 323-314; Moore et al., ibid., \$6, 1942, 247-254; Morales, Jour. Inf. Dis, 46, 1930, 31-35; Olitsky and Cox, Jour. Exp. Med., 63, 1936, 109-125; Paul et al , Am. Jour. Hyg., 17, 1933, 587-600; 601-612; Jour. Exp. Med., 71, 1940, 765-777; Sabin, tbid., 69, 1939, 507-516; Sabin and Ohtsky, thid., 68, 1938, 39-61; Sabin and Ward, tbid., 73, 1941, 771-733; 74, 1942, 519-529; 75, 1942, 107-117, Sabin et al., Jour. Bact., 31, 1936, 35-36 (Abst.); Sanders and Jungeblut, Jour. Exp. Med., 75, 1942, 631-649; Schultz and Gebhardt, Jour Inf. Dis., 70, 1942, 7-50; Schultz and Robinson, ibid., 70, 1942, 193-200; Stimpert and Kessel, Am. Jour. Hyg, 29, (B), 1939, 57-66; Theiler, Medicine, 20, 1941, 443-462; Theiler and Bauer, Jour. Exp. Med., 60, 1934, 767-772; Trask and Paul, ibid., 58, 1933, 531-544; 78, 1941, 453-459; Trask et al., tbid., 77, 1943, 531-514; Turner and Young, Am. Jour. Hyg., 37, 1943, 67-79; Wolf, Jour. Exp. Med., 76, 1942, 53-72; Young and Merrell, Am. Jour Hyg., 37, 1943, 80-92.

#### Genus II. Legio gen non

Viruses of the Poliname. probably because of : . also obvious involve. Latin legio, an army 6, segion.

. ...c.: usually there is us nervous system Generic name from

The type species is Legio debilitans spec nov.

## Key to the species of genus Legio.

I. Affecting man (see also IV below)

- II. Latent in, or affecting, mouse
- III. Affecting birds.
- IV. Affecting swine and swineherds.
- 1. Leplo debilitans succ. nov From Latin debilitare, to weaken or maim

Common names Poliomielitis virus, vieus of infantile paralysis.

Mosts . HOM IN IDAE -- Homo supiers L , man Experimentally. Cereopithecus acthions sabaeus, green African monkey; Macaca morday, M. mulatta, the rhesus monkey: M. was, the evnomoleus monkey, mona monkey; for some isolates, Stomodon histoidus Say and Ord, cotton rat : mouse , guinea pig; white rat

Insusceptable species : Sheep ("refractory"but forms neutralizing antibodica), chicken.

Geographical distribution: Almost world-nade.

Induced disease . In man, probably subclinical in most cases, in view of the presence of specific antibodies in sera from the great majority of adults in all narts of the world; virus probably infects some part of the alimentary tract, being found in stools of most clinical cases, of most apparently healthy contacts, and even of some individuals who have recovcend from abortive attacks fin one case 123 days after attack); chargal disease. largely in children, is characterized by investor of central pervous system, with effects rarging from sore threat, fever.

- - 1. Leoro debilitans. 2. Legra crebea.
  - 3. Leava simulans.
  - 4. Legio muris.
  - 5 Legra gallinge
  - 6 Legio sugriorum.

vomiting, and headache to sudden and severe paralysis; the muscles most often involved are those of the less, but there may be paralysis of abdominal or intercostal muscles. Virus not in urine or saliva, rarely in paral washings, more often in stools of young than of old patients: an walls of pharyax, deum, descending eolon Virus has been recovered from 925738 Incidence and fatality affected by racial characteristics, the first lower and the second higher in negroes than in whites in the United States. In monkey. similar disease, no virus in blood, relinise with responsance of virus reported; in isolated intestinal loops, infection does not occur through normal mucoes in absence of intestinal contents, disease more severe to summer than in autumn. in autumn than in winter, more severe in older than in younger monkeys; no immunity follows inoculation unless obvious distant occurs.

Transmission Transmission in mill has been suspected and at times confirmed. Virus has been recovered from mixed samples of flies in an epidemic area. No definite arthropod vector has been incriminated, Experimentally, in Cerconthecus aethiops sabaeus, the green guinea pig tissues immunize the guinea pig but vaccines made from mouse tissues do not. Mice immune to this virus are ausceptible to infection with pseudolymphocytic choriomeningitis virus and tree versa.

Thermal inactivation: At 55 to 56° C in 20 minutes.

Filterability: Passes Berkefeld V, N, and W filters and, with difficulty, a Seitz asbestos pad.

Other properties: Infective at least 206 days in storage at 4 to 10° C in 50 per cent neutral glycerine in 0.55 per cent saline. Infective particle calculated to be 37 to 55 millimicrons in diameter on the basis of centrilugation studies; 40 to 60 millimicrons by ultrafiltration tests. Inactivated by soap with less of mouse-immunizing capacity.

Literature Armstrong and Dickens, U. S, Pub. Health Service, Public Health Rept., 50, 1935, 831-842; Armstrong and Lillie, 161d, 49, 1934, 1019-1027; Armstrong and Wooley, 161d., 50, 1935, 537-541: Jour. Am. Med. Assoc., 109, 1937. 410-412; Baird and Rivers, Am. Jour. Pub Health, 28, 1938, 47-53; Casals-Ariet and Webster, Jour. Exp. Med., 71, 1940, 147-154; Dalldorf, abid, 70, 1939, 19-27; Dalldorf and Douglass, Proc. Soc. Exp. Biol. and Med , 59, 1938, 294-297; Findlay and Stern, Jour Path. and Bact., 43, 1936, 327-338, Findlay et al , Lancet, 230, 1936 (I), 650-651, Howard, Jour. Inf. Dis., 64, 1939, 66-77, Laigret and Durand, Compt. rend. Acad. Sci., 203, 1936, 282-284; Lépine and Sautter, Ann. Inst. Pasteur, 61, 1938, 519-526; Lépine et al., 161d., 204, 1937, 1846-1848, Mac-Callum and Findlay, Brit. Jour. Exp. Path , 21, 1940, 110-116; Milzer, Jour. Inf. Dis., 70, 1942, 152-172, Rivers and Scott, Jour. Exp. Med., 65, 1936, 415-432; Scott and Elford, Brit. Jour. Exp. Path., 20, 1939, 182-188; Scott and Rivers, Jour. Exp. Med., 63, 1936, 397-414; Shaugnessy and Ziehis, 1bid., 72, 1940, 331-343; Smadel and Wall, :bid , 72, 1940, 389-405; 75, 1942, 581-591; Smadel et al., Proc. Soc. Exp. Biol. and Med., 40, 1939, 71-73;

Jour. Exp. Med., 70, 1939, 53-65; 71, 1910, 43-55; Stock and Francis, thid, 77, 1943, 322-336; Traub, Science, 81, 1935, 293-299; Jour. Exp. Med., 82, 1935, 53-8, 847-861; 64, 1936, 183-200; 66, 1937, 317-324; 68, 1938, 95-110, 229-250; 69, 1939, 801-817.

3. Leglo simulans spec. nov. From Latin simulare, to imitate, in reference to resemblance of this virus to the preceding in many respects, though not in size or antigenic properties.

Common name: Pseudo-lymphocytic choriomeningitis virus,

Hosts: HOMINIDAE—Homo sapiens
L., man. Experimentally, also mouse,
guinea pig, rhesus monkey; choricallantoic membrane of chick embryo.

Induced disease In man, benign aseptic lymphocytic meningitis with virus
in cerebro-spinal fluid; severe Instal
headache, drowsness, irritability, voniting, eventual complete recovery. In
mouse, experimentally, roughened fur,
spontaneous tremor, hunched attitude,
irritability, clonic movements ending
with tonue convulsions on stimulation,
temporary recovery from spasm with
surveyal a few hours or instant death.

Serological relationships: Hyperimmune sera for lymphocytic choriomeningitis virus are ineffective for this virus, and nice versa. In man, after recovery, neutralizing antibody is strong at 1 month, fading before 7 months.

Immunological relationships: Mice acquire specific resistance to reinfection after experimental disease; mice immune to lymphocytic choriomeningilus virus are susceptible to pseudo-lymphocytic choriomeningilis virus and stee versa.

Thermal inactivation: At 56° C, not at 45° C, in 30 minutes.

Filterability: Passes Berkefeld V, not N, filter candle, Gradacol membrane of 320, not 300, millimicron average pore diameter.

Other properties: Particle diameter calculated to be not above 150 to 225 millimicrons, from filtration experiments.

2. Leglo erebea spec. nor. From Latin cheus, belonging to the Lover World. Common names: Choriomeningitis virus, lymphocytic choriomeningitis virus. Hosts: MURIDAE—Mus musculus L. vay or white mouse. HOMINIDAE—homosapieris I, man. CERCOPTHECTI-AI:—Macora mudalta, rhesus monkey experimentally, also guinea pig, white it, dog (masked), ferret (masked), facaca irus, crab-eating macaque, Syrin hamster; chuck- or mouse-embryo erum Tyrode solution culture, check mbrao.

Insusceptible species Pig, rabbit, ield vole, bank vole, canary, hen, paracet.

Geographical distribution France,

England, United States. Induced disease. In white mouse, more virulent in young than in old individuals. infection may take place in utero or soon after birth, some mice become carriers after recovery, with virus in organs, blood, urine, and masal secretions, carriers are immune to large intracerebral inoculations of virus, experimentally, 5 to 12 days after intracerebral anoculation of susceptible nuce, somnolence, photophobia, tremors of the legs, tonic spasms of muscles in the hindquarters upon stimulation, recovery or death. In man, disease may be subclinical at times as shown by the fact that some supposedly normal sera contain specific antibodies, not all clinical cases develop protecting antibodies against testing strains so that disease may be somewhat commoner than can be ascertained readily, in all cases benign, but in the more severe of these an acute aseptic meningitis, after incubation period of 14 to 3 days, spells of fever extending as long as 3 weeks, late in the disease there may be a meningeal reaction both chinically and cytologically, lymphoexter and some large mononnelear cells anyear in the meningral fluids, although symptoms remain benign, there may be virus in the blood from the beginning of fever to the end of the second week, the spinal fluid is not infective at first but may become so before there is a change in cell count, urine and saliva remain uninfectious.

Transmission: In white mouse, by contact with mice infected when young, not with those infected when old; massi mucosa considered portal of entry. In wild gray mouse of the same species, Mus musculus, by contact but less readily than in whate mouse. Experimentally, by mosquito, Addos eegyptil. [CULICI-DAE], at 26 to 34° C, by hedbug, Cimer lettularus [CIMIDAE], but defectation on site of bitten area is essential, bite atone being ineffective. Experimentally, to guince pig, by application of virus to normal and apparently intact skin; not by contamination of food or litter.

Serological relationships. Serum of recovered subjects usually neutralizes choriomeningstis virus. Hyperimmune serum is ineffective against pseudo-lymphoeytic choriomeningitis virus and hyperimmune scrum for that virus is inclfeetive in its turn when used with chonomeningitis virus. No cross neutralization with St. Louis encephalitis virus A specific soluble antigen assoesated quantitatively with virus in all hosts fives complement in the presence of immune scrum, virus does so poorly of at all , the anti-soluble substance antibodies seem to be independent of virusneutralizing antibodies. A soluble protem, readily separable from virus, gives a specific precipitin reaction with immune serum, antibodies concerned are probably not the virus-neutralizing antibodies.

Immunological relationships—Intraperationed injection of about 160 intracerebral lethal doses has been found to protect the whate mouse against infection by subsequent intracerebral injection of 10,000 fethal doses. The immune mouse differs from the immune guinea pig in showing no neutralizing antibodies in its blond, even the purses pig may develop resistance before antibodies appear in its serum. Formalized vaccines made from Cent. f. Ba'tt., I Abt., Orig., 142, 1938, 144-148; Iguchi, Kitasato Arch. Exp. Med., 16, 1939, 56-76; Olitzky, Jour. Exp. Med., 72, 1940, 113-127; Theiler, Science, 80, 1934, 122; Jour. Exp. Med., 55, 1937, 705-719; Theiler and Gard, bid., 72, 1940, 49-67, 79-90; Young and Cumberland, Am. Jour. Hyg., 37, 1943, 216-294

 Legio gallinae spec. nov. From Latin gallina, hen.

Common names: Avian encephalomyelitis virus, infectious avian encephalomyelitis virus.

Host: PHASIANIDAE—dallus gallus (L.), chicken (embryo not susceptible; in culture media, mineed whole embryo in serum-Tyrode solution suffices to maintain virus, but embryo brain alone does not).

Insusceptible species: All tested species other than birds.

Geographical distribution: United States.

Induced disease: In chicken, fine or coarse tremors of whole body or only of head and neck or of legs; progressive ataxia, eyes dull, some loss of weight, weakness of legs, and progressive meoordination of leg muscles; somnolence precedes death, about 75 per cent die within 5 days of onset, 90 per cent within a week, the remainder showing a staggering, ataxic gast for weeks, some continuously tremulous; recovered birds. however, may produce eggs well, microscopic focal collections of glia cells, perivascular infiltration, degeneration of Purkinje's cells and degeneration of nerve cells; foct of infiltration throughout brain and spinal cord, virus not detected in the blood of affected chickens.

Transmission. Not through egg. Experimentally, by intracerebral injection. Serological relationships. Specific anti-

Serological relationships "openic antoserum neutralizes homologous virus but not the Eastern strain of equine encephalitis virus, autiserum specific for the latter does not neutralize avian encephalomyelitis virus. Filterability. Passes Berkefeld V and N as well as Seitz 1 and 2 filters; also membranes 73 millimicrons in average pore diameter.

Other properties: Survives in 50 per cent glycerine for at least 83 days and frozen for at least 68 days. Infective particle estimated to be 20 to 30 millimicrons in diameter, by filtration studies

Literature: Jones, Science, 76, 1933, 331–332; Jour. Exp. Med., 59, 1934, 781–798; Kligler and Olitsky, Proc. Soc. Exp Biol. and Med., 42, 1940, 680–683; Olitsky, Jour. Exp. Med., 70, 1939, 555–582; Olitsky and Bauer, Proc. Soc. Exp. Bol. and Med., 42, 1939, 634–636; Van Roekeletal, Jour. Am. Vet. Med. Assoc., 93 (N.S. 46), 1938, 372–375.

 Legio suariorum spec, nov. From Latin suarius, swineherd.

Common name: Swineherds'-discase virus,

Hosts: SUIDAE—Sus scrofa L., swine. HOMINIDAE—Home septem L., man. Experimentally, with fever as only symptom, white rat, cat, ferret, mouse; perhaps Macaca mulatta (Zummermann), rhesus monkey.

Geographical distribution : Europe.

Induced disease In man, a beniga meningitis without sequelae, somewhat similar to lymphocytic choriomeningitis in man; cell counts in spinal fluidsmay be as high as 1200 to 1400; 4 to 7 (average 8) days after infection, fever lasting 3 to 21 days (average 9); sometimes conjunctivitis, more often a reddish maculopapillose eruption; severe sweating frequent; hemorrhagic tendency; blood in feces; recovery. Blood, urine, feces infectious, not spinal fluid or murous exerctions. Especially affecting young men, not often old men or women, among those having contact with swine or swineproducing quarters.

Transmission: Exercta of pigs, even as used for manure, are infective. Experimentally, to man, by subdermal or intramuscular injection. Viable at least 1 month at 4° C, at least 1 year in 50 per cent glycerine. 40 days in 0.25 per cent phenol, 1 year when dried from frozen material. Inactivated by 0.05 per cent formalia at 4° C in 48 hours; by boiling in 5 minutes.

Laterature: MacCallum et al., Brit. Jour. Exp. Path., 20, 1939, 260-269.

4. Leglo muris spec. nov. From Latin mus, mouse.

Common names Mouse-poliomyelitis

Host MURIDAE-Mus musculus L.,

Insusceptible species CERCO-PITHECIDAE-Macaca mulatia (Zim-

mermann), rhesus monkey.

Geographical distribution: United
States, Japan, Germany, Palestine; probably widespread wherever white mice are

raised. Induced disease. In white mouse, ordinarily no obvious disease, virus occurring in feces and not being recoverable from thoracic or abdominal viscera or head (probable source is in abdominal wall, virus has been recovered most abundantly from intestinal contents, in moderate amounts from walls of intestine and in smaller concentration from mesenteric lymph glands), occasionally, individual mice show flacerd paralysis of land legs, and brain or spanal-cord suspensions from these contain the virus. nuce modulated intracerebrally show flacerd paralysis in 7 to more than 30 days. first in one limb, later usually in all , the tail does not become paralyzed, very young noxulated mice may die without first showing paralysis, very old moculated mice may become infected without showing obvious disease, some affected mue recover and those showing residual paralysis may become carriers of virus In affected, experimentally inoculated muce, arute premeis of garglion cells of anterior born of spinal cord, necrosis also of sadsted gangleon cells of cerebrum. Inter, marked neuronophagia. Perivascular infiltration in brain and spinal cord.

The reciprocal of the incubation period has been found approximately proportional to the logarithm of the amount of virus inoculated, thus serving to measure the concentration of samples of virus. Old mice less susceptible than young.

Transmission. Experimentally, by intracerebral, intransal and intraperitoneal inoculation. Has been found to persist in adult flies, Museca domestica L. (MUSCIDAE) and other species, as long as 12 days after experimental feeding whereas mouse-adapted human poliomyclitis virus persists only 2 days in Musea domestica and not at all in some other species.

Serological relationships. Sera containing antibodies to the Lausing strain of human poliomyelitis virus fail to protect against mouse poliomyelitis virus.

Immunological relationships: Recovered mine are immune to various beterologous isolates or strains. No evidence of immunological relationship with virus of human polomyelitis has been obtained, save that mice paralyzed with mouse polomyelitis virus show some resistance to infection with the Lansing strain of human polomyelitis virus, this has been interpreted as possibly no more than an interference phenomenon, since it seems to depend on actual pri 1988.

Filterability: Passes Berkefeld N and other Berkefeld filters and Chamberland La filter

Other properties Viable at least 14 months at -75° C, at least 150 days in 50 per cent glycerine at 2 to 4° C. Most stable near pll 80 and pll 33. Inactivated readily at 37° C by 1 per cent hydrogen perovide. Particle dameter estimated as 9 to 13 millimerons from fittration studies. Sedimentation constant, S<sub>11</sub> ~ 100 to 170 × 10<sup>-18</sup> cm per sec. per dyne.

Laierature Bang and Gluser, Am. Jour, Hyg. 37, 1912, 220-231, Galacan and Stevenson, Jour Int. Dia., 62, 1911, 232-237, Gard, Jour. Exp Med., 72, 1910, 60-77, Gard and Pedersen, Science, 34, 1911, 433-431, Gildemeinter and Ahlfeld, of rabid horses or cattle. Not by contamination of food. In Brazil and Trinidad, probably by the vampire bat, which has been found infected in nature.

Serological relationships: Specific flocculation of rabies virus occurs in the presence of immune serum from rabbit or guinea pig; strains differ in relative amounts of antigenic constituents, as shown by absorption tests. Complement fixation occurs in the presence of virus and guinea-pig antiserum. Neutralizing antibodies are specific.

Immunological relationships: Virus exposed to ultraviolet light tends to loss its virulence before its immunizing potency. Passive immunization succeeds in white mice if antiserum is injected intracerebrally hour before, but not 24 hours before or 2 hours after, virus. Chloroform-treated vaccines more effective than phenolized vaccines, but irritative.

Thermal inactivation: At 60 to 70° C in 15 minutes; in brain tissues, at 45° C in 21 hours.

Filterability: Passes Berkefeld V filter. Other properties: Viable at least 2 months at 5°C in liquid or dry state. Infective particle between 100 and 240 millimicrons in diameter, by filtration studies.

Laterature: Bernhopf and Kligher, Brit. Jour. Exp. Path, 18, 1937, 481–485; Casals, Jour. Exp. Med., 72, 1949, 445–451, 453– 461, Covell and Danks, Am. Jour. Path., 8, 1932, 557–572, Dawson, Science, 88, 1939, 300–301; Am. Jour. Path., 17, 1941, 177–188, Galloway, Brit. Jour. Exp. Path., 15, 1931, 97–105, Goodpasture, Am. Jour. Hyg., 1, 1925, 547–582; Haupt and Rehang, Zischr. f. Infektionskrankh., 22,

1921, 76-88, 104-127; Havens and Mayfield, Jour. Inf. Dis., 50, 1932, 367-376; 51, 1932, 511-518; 52, 1933, 364-373; Henderson, Vet. Med., 37, 1942, 88-89; Hodes et al., Jour. Exp. Med., 72, 1940, 437-444; Hoyt et al., Jour. Inf. Dis., 59, 1936, 152-158; Hurst and Pawan, Lancet, 221, 1931 (2), 622-628; Jour. Path. and Bact., 35, 1932, 301-321; Johnson and Leach, Am Jour. Hyg., 32 (B), 1940, 38-45; Kligler and Bernkopf, Proc. Soc. Exp. Biol. and Med., 39, 1938, 212-214; Am. Jour. Hyg., 35 (B), 1911, 1-8; Leach and Johnson, ibid., 32 (B), 1940, 74-79; Metivier, Jour. Comp. Path. and Therap., 48, 1935, 245-260; Peragallo, Giorn, di batteriol, e immunol., 18, 1937, 259-290; Snyman, Osderstepoort Jour. Vet. Sci. and Anim. Indust., 15, 1940, 9-140; Webster, Am Jour. Pub. Health, 26, 1936, 1207-1210; Jour. Exp. Med., 70, 1939, 87-106; Am. Jour. Hyg., 30 (B), 1939, 113-134; Webster and Casals, Jour. Evp. Med., 71, 1910, 719-730; 73, 1911, 601-615; 76, 1912, 185-194: Webster and Clow, 1bid, 66, 1937, 125-131; Wyckoff, Am. Jour. Vet. Res., 2, 1941, \$4-90.

Note: The Negri body, a characteristic cell-inclusion in rabies, has been given the following names under the supposition that it represents stages in the life cycle of a protozoan narasite responsible for the disease: Neuroytes hydrophona by Calkins, Jour. Conceus Diseases including Syphilis, 25, 1007, 510. Engelitozoon rabiei by Manouelian and Viala, Ann. Inst. Pasteur, 38, 1924, 238, and Glugea lysase by Levaditi, Nicolau and Schoen, Ann. Inst. Pasteur, 40, 1926, 1048

Serological relationships. Serum from recovered cases neutralizes the virus Immunological relationships: Specific immunity follows attack of the disease Differentiaty Passes Chamberland Lz filter Literature: Durand et al., Compt. rend. Acad. Sci., Paris, 203, 1936, 830-832, 937-959, 1032-1034; Arch. Inst. Pasteur for Tunis, 26, 1937, 213-227; 228-249, 27, 1938, 7-17.

### Genus III Formida gen. nov.

Viruses of the Rabies Group, inducing diseases characterized by involvement of the nervous system only. Generic name from Latin formulo, a frightful thing. The type and only recognized species is Formulo inexpendities spec. now

l Formido inexorabilis apec. nov. From Latin inexorabilis, implacable Common name - Rabies virus

Bosts CANIDAE-Cants familiaris FELIDAE-Felis catus L., domestic cat . F negripes, black-footed cat . F acreata, wild cat, HOMINIDAE-Homo sapiens L., man. MUSTELI-DAIL-letanuz orangiae, polecat URIDAE-Geosciurus capensis, ground VIVERRIDAE-Connetis penicillata, vellow morgoose (vellow meereat), Genetia felina (Thunb), renet cat. Myonax pulicrulentus, small, grey mp mouse. Suricata suricatta. Cune suricate or common meercat Cattle, sheep, my horse, wolf Cynalopez chama, silver rackal Phyllostoma superciliatum, vammre bat . Dismodus rufus, vammre bat . Artibeus planicostris trinitatis, fruit-ent ing hat 1 sperimentally, also Mus musentur I. , white mouse . Peromuscus polionotus polionotus (Wagner), white footed mouse, tissue cultures of 5 or 6-day-old ent or mouse-embryo brain, chick embrue callantois not regularly infected. but vir is regularly reaches brain of embecowethout morning it , chick may batch with tites of 1 100 or 1 1000 in brain) Chirlen , mouse hank (Buteo sulgaris); prgean, owl, goose, stork (Ciconia eiconia). these at (Diardiarlus diardi BP) Insuceptible species Reptiles, fish

In secretable species, heptites, hish No mammal is known to be mausceptible. Geographical distribution. Almost world wide, absent only from relatively pointed countries or communities.

Induced discuss. In dig, after a short

incubation period (generally less than 10 days) altered behavior, hiding, lack of obedience, perverted appetite leading to ingestion of straw, paper, earth, and other unaccustomed materials, excitement, unprovoked being (which may transmit the virus to new hosts), simless wandering, excess salivation, progressive inability to swallon, alteration of bark to characteristic high nitched tone, stagggroup, paresis of hindowarters tending toward paralysis and involvement of auterior parts of the body, paralysis of lower jaw, muscular spasms, marked emscration, death except perhaps in rare instances. In man, after a relatively long incubation period depending on site of implantation (perhaps 27 to 61 days), a uniformly fatal disease, characterized by altered behavior, increased excitability, thirst, pharyageal spasm with progressive inability to swallow. Inbored and possy respiration, death in 3 or 4 days after onset, with or without purovem. In sheep, mereased sexual desire, tendency to pull wool from other sheen or themselves; light butting, increasing until some ewes, after violent exercise, appear to faint, prostration within I to 4 days, death within 2 days. from onset of locomotory paralysis. In mouse, experimentally, by intracerebral moculation, apathy, sluggishness, roughening of hair, tremor, convulsions, prosdeath, cometimes paralysis of hand legs before death, Transmission Usually by bite of doe

or some closely related animal, occasionally by bites of cats, rarely by bites Litmus milk: Acid, not digested., Potato: No apparent growth.

Indole is formed.

Nitrites produced from nitrates.

Ammonia is produced. Acid from glucose, lactose, maltose,

sucrose and starch. Aerobic, facultative,

Optimum temperature 20°C. Habitat : Soil

49 Pseudomonas tralucida Kellerman et al. (Kellerman, McBeth Scales and Smith, Cent. f. Bakt., II Abt , 39, 1913, 37; Cellulomonas tralucida Bergey et al., Manual 1st ed., 1923, 163) From Latin, clear, transparent.

Rods 0.6 by 1 2 microns. Motile with one or two polar flagella. Gram-negative. Gelatin stab: No liquefaction.

Agar slant: Scant, gravish growth.

Broth · Turbid.

Litmus milk: Acid.

Potato: No growth. Indole not formed.

Nitrites produced from nitrates.

Ammonia not produced Acid from glucose, maltose, lactose,

sucrose, starch, glycerol and mannitol. Aerobic, facultative.

Optimum temperature 20°C.

Habitat : Soil.

50 Pseudomonas mira McBeth. (Mc-Beth, Soil Science, 1, 1916, 437; Cellulomonas mira Bergey et al., Manual, 1st ed., 1923, 165.) From Latin, mirus, wonderful, extraordinary.

Rods: 0 4 by 1 6 microns. Motile with a single polar flagellum. Gram-negative. Gelatin stab: Good growth. No lique-

faction. Agar colonies: Circular, convex, grayish-white, granular, lacerate

Agar slant: Moderate, flat, grayishwhite, somewhat iridescent.

Broth: Turbid.

Litmus milk: Alkaline.

Potato Moderate, grayish-white. Indole not formed.

Nitrites produced from nitrates. Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol,

Aerobic, facultative. Optimum temperature 20°C.

Habitat : Soil.

Pseudomonas lindneri Kluyver and Hoppenbrouwers. (Lindner, 50 Jubiläumsber. Westpreuss. Vereins, 1928, 253; Termobacterium mobile Lindner, Atlas d. Mikrosk. Grundl. d. Garungsk., 3 Aufl., 2, 1928, Taf. 68; Kluyver and Hoppenbrouwers, Arch. f. Mikrobiol., 2, 1931, 259; Achromobacter mobile Kluyver and Hoppenbrouwers, ibid., 258; not Pseudomonas mobilis Migula, Syst. d. Bakt., 2, 1900, 923.) Named for Lindner, the German bacteriologist who first studied this organism.

Short rods 1.4 to 2.0 by 40 to 50 mierons. Occurring singly, in pairs and short chains. Motile with a single polar flagellum. Gram-negative.

Peptone gelatin: Poor growth. Peptone agar: Poor growth.

Wort agar: White, round, raised colonies, 1 mm. in diameter. Good growth Still better where 2 per cent sucrose, or yeast extract with sucrose is added. Chalk added to neutralize acid.

Broth: Poor growth in peptone or yeast extract broth unless sugars are added.

Carbon dioxide, ethyl alcohol and some lactic acid produced from glucose and fructose, but not from mannose. May or may not ferment sucrose. May produce as much as 10 per cent alcohol.

Catalase produced.

Anaerobic, facultative,

Optimum temperature 30°C.

Distinctive character: The fermentation resembles the alcoholic fermentation produced by yeasts.

Source: Isolated from the fermenting sap (pulque) of Agave americana in Mexico.

Habitat. Fermenting plant juices in tropical countries (Mexico).

#### FAMILY IV. CHARONACEAE FAM. NOV.

Viruses of the Yellow-Fever Group, unducing diseases mainly characterized by fever and necrosis of tissues in the absence of obvious macule, napule, or vesicle formation or of conspicuous involvement of nerve cells.

#### Key to the genera of family Charonaceae.

I Viruses of the Typical Yellow-Fever Group. Genus I. Charon, p. 1265.

II Viruses of the Influenza Group

Genus II Tarpeta, p 1268.

III. Viruses of the Hog-Cholera Group

Genus III. Tortor, p 1275.

## Genus I. Charon gen nov.

Viruses of the Typical Yellow-Pever Group, inducing diseases mainly characterized by neute non-contagious fever Vectors dipterous insects, so far as known. Generic name from Latin Charon, ferryman of the Lower World

The type species is Charon ergoatus spec war

### Key to the species of genus Charon.

I Vectors mosquitoes

1. Charon ergogius.

II Vectors unknown, perhaps mosquitoes

2 Charon vallus

1. Charon evagatus spec. nor. I'rom

Latin gracer, to spread abroad Common name Vellou fever virus

Hosts HOMINIDAE-Homo sapiens L. man. Experimentally, also Cereanitheeus tantalus Ogilhy, C. aethiaps, African guenon (symptomiess), Cerco cebus torquetus (Kerr), collared manga bey; Mus musculus L., mouse, Microtus agrestis, field sole, Sciurus rulgaris L., red squirrel, Macaca mulatta (Zimmer mann i, riesus monkes . Macaeus sinieus Indian crown mankey, If cynomolous, M speciosus, Erinaccus europaeus, heilgo how, Gallus gallus (l.,), clucken (tol. erant). Dosuprocta aguts, apouts (serral messer faile

Insusceptable species (at ferret, rib bit, rit, Cricelus auratus, golden ham ster. Apolemus sylvaticus, nexal vole, Frotomys glariolus, bank vole; pigeon, catary, paparelle bat, Cricelomes gambinnus, possibled sat, dog, gent.

Geographical distribution. Tropical re-

gions in general, especially Central and South America, West Indies, West Africa, anti-mosquito campaigns have tended to eradicate vellow-fever virus from parts of its former tance.

Induced disease. In man, mild cases may occur, especially in natives where the disease is endemic, but in Europeans cenerally sudden fever without marked chappe in miles rate after a 3 to 6-day incubation period, severe frontal headache, pains in the loin and less and epigastric pain, gradual decrease in temperature to 95 or 99° I', weakening of pulse and slowing of heart beat in the ab-ence of further temperature changes; pundice, especially in sclerae, often in skin, albumen in urine, later bile-pigmentaalso present , bemorrhages frequent especially in alimentary canal; fatty and mecrotic changes in the liver; acute deceneration of renal parenchy ma, splenic congestion; death may occur in the early acute state, but is more likely about the fifth or sixth day; relapses may occur until 2 or 3 weeks after onset; case mortality varies from 10 to 90 per cent in different epidemics. A transitory immunity due to transfer of serum antibodies through the placenta protects offspring of immune mothers for a short time.

Transmission: By mesquitoes, Aédes aegypti L., Aedes leucocelaemus (D. and S.). Haemogogus capricorna Lutz (CULICIDAE). The mosquito Aedes aegypti becomes infective, after feeding on a suitable virus source, in 4 days at 37° C, 5 days at 36° C. 6 days at 31° C. 8 days at 25.1° C. 9 to 11 days at 23.4° C. 18 days at 21° C, and 36, not 30, days at 18° C; virus in head, thorax, and abdomen before bites are infective; no evidence of transmission of virus through eggs to offspring or to larvae eating infected adults. Experimentally, also by Aêdes scapularis (Rondani), A. fluviatilis (Lutz), A. luteocephalus, A. apreo-annulatus (CULICIDAE). Experimentally, by feeding, to Macaca mulatta and Cerconthecus aethiops; by rubbing infected blood into intact and unshaved skin of monkeys.

Serological relationships Complementfixation and precipitating antibodies are specific.

Immunological relationships: A specific immunity develops after an attack of the disease or after vaccination with virus grown in media containing tissues of chick embryo minus head and spinal cord.

Thermal inactivation. At 55 to 60° C, not at 50° C, in 10 minutes

Filterability Passes membranes of 55, and to some extent membranes of 50, millimicron average pore diameter. Passes Berkefeld V and N, as well as Chamberland F, filters.

Other properties: Particle estimated from filtration data to have a diameter of 17 to 28 ruillimicrous; by ultracentralugation data, 19 millimicrons. Inactivated or inhibited by 30-minute exposure to 1:15 formalin, 1.6 ethyl alcohol; 1:300

yellowish eosin, 1:50 sodium oleate, 1:200 liquor cresolis compositus; viable after 30-minute exposure at 30° C to 1:7500 mercuric chloride, 1:150 phenol, 1:1500 mercuric chloride, 1:150 phenol, 1:1500 hexylresoretinel, 1:150 sodium oleate. Sedimentation constant between 18 and 30 × 10<sup>-13</sup> cm per sec. per dyne. Viable in 50 per cent glycerine at 2 to 4° Cfor 58, not for 100, days; in mouse brain at -5° C for 160 days. Viability may be lost on simple drying but retained if drying is carried on in sucus over a desicating agent.

Strains: Distinctive strains have been isolated. One, to which much study has been given, differs from the typical viscorotropic strain by possessing marked neurotropic or pantropic characteristics.

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703-717; Ramsey, Am. Jour. Hyg., 15, 1931, 129-163; Sawyer, ibid., 25, 1937, 221-231: Shannon et al , Science, 88 1938, 110-111; Smith and Theiler, Jour. Evn. Med., 65, 1937, 801-808; Smith et al., Am Jour. Trop. Med., 18, 1938, 437-468, Soner and De Andrade, Am. Jour Hye. 18. 1933, 588-617; Soper et al , ibid., 18, 1933, 555-587; 19, 1934, 549-566, 27, 1938, 351-363. Stefanopoulo and Wassermann. Bull. Soc Path. Exet . 26, 1933, 557-559 . Stokes et al., Am. Jour. Trop. Med., 8 1928, 163-164, Theiler, Ann. Tron. Med and Parasit., 24, 1930, 249-272, Thesler and Smith, Jour. Evn Med . 65, 1937. 767-786, 787-800, Whitman, abid., 66. 1937, 133-143,

2. Charon vallts spec, nov. From Latin rallis, valley.

Common name Rift Valley fever virus Hosts HOMINIDAE-Homo sapiens L. man. BOVIDAE-Bos taurus L. cow; Oris aries L , sheep, Capra hircus L. coat Experimentally, also Sciurus earolinensis, grey squirrel, ferret, Cricetus auratus, golden hamster: Anodemus sulvations, wood mouse. Microtus agrestis field vole, Muscardinus avellanarius, dormonse, rat, mouse, Macaca mulatta, M. irus, Cebus fatuellus; C. chrusopus; Havale rocchus: Il nenicillata: Cereonethecus callitrichus (symptomless), Eruthrocebus palas (symptomicss): Cercocebus fuliginosus (symptomices), chick embryo in Tyrode's rolution, choricallan toic membrane of cluck embrao

Insusceptible species Horse, pig Geographical distribution British East Africa.

Induced disease In man, beings discase, after 5] to 6 days, rigors, pains in lack, fever for 12 to 30 hours, followed by recovery, with persistence of acquired immune bodies as long as 4 to 5 years after infection. In sleep (lambs), dullness, rapid respiration, collayee and death in a few hours or a chrome course, focal necrosis in liver. In chornollantoic membrane of chick embryo, experiment

tally, areas of hyperplasia and of necrosis; connective tissue inflamed nearby; liver of embryo mottled with necrotic areas.

Transmission: Not by contacts. Mosquito, Taeniorhynchus brevipalpis (CUL-ICTDAE), suspected as possible vector. Scrological relationships. Antisers for prittacesis, dengue fever, and sandly fever viruses fail to protect against infection with Rift Valley fever virus. Specific neutralizing autibody in intraperitoneally neutral myture with Rift Valley fever virus may be dissociated so as to free virus by direct dilution in saline solutions, but named in control to the production of the proposition of a small dose, all methods proteably inchying a dilution effect.

Immunological relationships: No cross immunity with yellow-fever or dengue-fever viruses. If Rift Valley fever virus is inoculated into rheus monkey simultaneously with yellow-fever virus, the animal tends to be protected against death from yellow fever (interference effect), but one-dry earlier inoculation of Rift Valley fever virus does not protect.

Thermal mactivation At 56° C in 40, not 20, montes.

Fitterability: Passes Berkefold V, N, and W fitters; passes Chamberhand Le, Le, Le Lu, Lu and occasionally Lu fitters, passes membranes 150 millimerons in average pore diameter freely, 90 millimerons with defficulty, 70 millimerons and at all

Other projectics. Viable at least 8 months at 4°C, more than 4 weeks dry in liver tissues, 6 months in ½ per cent carbolic acid at 4°C. Diameter of infective particle estimated from fillration studies to be between 23 and 35 millimiteross.

Strains A neurotropic strain Imnumizes limbs without producing obvious illness, if given subcutaneously

Literature Broom and Findlay, Brit. Jour Exp Path, 14, 1933, 170-181; Daubney et al., Jour. Path, and Bact., 24, 1931, 545-579; Findlay, Trans. Roy.

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## Genus II. Tarpela gen. nov.

Viruses of the Influenza Group, inducing diseases characterized principally by involvement of the respiratory tract. Generic name from Latin Tarpeia, name of a Roman maiden who treacherously opened a citadel to an enemy.

The type species is Tarpeia alpha spec, nov.

## Key to the species of genus Tarpeia.

- Infecting man principally.
- 1. Tarpeia alpha. 2. Tarpeta bela.
- II. Affecting feline species.
- 3. Tarpeia premens.
- 4. Tarpeia felis III. Affecting domestic cattle (calves).
- 5. Tarpera ritulac.
- IV. Affecting capine species.

V. Affecting ferrets.

- 6. Tarpeia canis.
- VI. Affecting domestic fowl.
- 7. Tarvera vulpis.
- 8. Tarpeia viverrae. Tarpeia arium.

1. Tarpela alpha spec, nov. From first letter of Greek alphabet

Common name Influenza A virus: swine filtrate-disease virus.

Hosts: HOMINIDAE-Homo sapiens L., man SUIDAE-Sus scrofa L., domestic swine. Experimentally, also ferret. mouse, Macacus irus, hedgehog, rabbit (inapparent infection), guinea pig (inapparent infection), rat (inapparent infection): Mustela sibirica Milne-Edwards, Chinese mink; Sciurotamius davidianus Milne-Edwards, David's squirrel, chick embryo (some strains produce visible lesions at 36.5° C on chornoallantoic membrane); minced chick embryo in Tyrode's solution.

Insusceptible species: Callosciurus caniceps canigenus Howell, Chekiang squirrel; Eutamias asiaticus senescens Miller, chipmunk.

Geographical distribution: World-wide. Induced disease: In man, headache, dizziness, with shivering and muscular pains; rise of temperature on the second day, sometimes with fall on the third and elevation again later; often complicated by bronchitis and bronchopneumonia; hemorrhame and edematous lobular consolidation in lungs; virus most easily recoverable from nasopharyngeal washings, but also from nasal secretions and lungs. In swine, virus alone produces only a mild malady (filtrate disease);

in the presence of Haemophilus influenzac suts a severe maiady occurs under both natural and experimental conditions; it involves fever, cough, and prostration; many infected animals die. Lungworms, Metastronoulus elononius and Choeropudendotectus GIETAstrongulus STRONGYLIDAE). from interted swine harbor virus at least 2 years, living meant me in earl buorms, such as Allolobophora caliginora (LUMBRICIDAE). which are eaten eventually by swine. The swine are refractory to viral infection during May, June, July, and August, but the disease may be invoked later by successive intramuscular injections of Hoemophilus influenzae mus or other stimuli, such as feeding embryonated iscarisova. In infected swine, virus occurs in turbinates, tracheal exudates, and lungs, not in spleen, liver, kidnes. mesentene lymph nodes, brain, blood, or murous of colon Neutralizing antibodies annear later (7th to 10th day) in the mild filtrate disease than in typical swine influenza, to which they appear about the 6th to the 7th day, maximum titer on 11th to 27th day. Experimentally in mouse, not contagnous as in swine and not dependent on the coexistence of a in terral companent, death of earthelium of respiratory and terminal branchioles. complete epithelial desquamation, dilata tion of hypichioles, collapse of alveols, in healing, widespread epithelial prolifera-Experimentally in ferret, mod erate apaths, lack of appetite, pallor of mose, variable entarrhal symptoms, at acute stage of disease, necessary of respiratory epithelium of pasal mucous membrane, with desquantation of superficial cells exudation into air propages and inflammature reaction in the submucosa. repair follows, beginning on the 6th day after infection and becoming exentially complete at the end of 1 month, after recovery the ferret is immune for 3 mentle or nore with subsequent naming of resistance, subsequent auteutaneous invulations of time restore immunity. Transmission: Presumably by droplets; for example between cages of ferrets as close as 5 feet apart, even to levels 3 feet higher than cage of diseased individusls. Experimentally, from washings of human throats to ferret, mouse, chickembryo (by amniotic route and to allantole membrane); a mice, by contact and by inhalation of fine droplets.

Serological relationships: Neutralizing antibodies common in human sera from individuals above 10 years of age; rarer in sera from young children; strongly effective for homologous, weak for heterolocous, virus in convalescent sem. Soluble complement-fixing antigen of snine strain has components in common with antigens of human strains (PR8 and WS). Complement fixation best 10 to 14 days after onset in man. Inactivating capacity of masal secretions proportional to level of neutralizing antibodies in blood. Agglutination of red cells by influenza virus is inhibited quantitatively by attentio antiserum

Immunological relationships. Specific immunization of ferrets, without obvous disease, occurs as a result of intranasal inscribitation of egg-passage influent a virus that is not transmissible from ferret to ferret. In mice, immunizing dose is directly proportional to degree of indiared immunity, immunity to the strain used in immunitation is more effective in general than that to heterologous isolates of the virus.

Filtersbitty Passes Berkefeld V filter. Other properties Parviele sure estimated as 80 to 120 milliamerons by filterstant studies, 80 to 90 milliamerons by ultracentrifugation (S<sub>24</sub> = 724 × 10<sup>-24</sup> cm per see per dyne), electron memographs show bean or kindry-shaped particles, or round particles with central dense syst, averaging 7.5 milliamicrons in diameter. Instituated by olcie, hoole and Insdams scales without loss of immuniting ability. Insatinated by ultraviolet radiation.

Intersture Andrewes and Glover.

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1942, 338-353; Lennette and Horsfall, Jour. Exp. Med., 78, 1941, 581-599; Loosli et al , Jour Inf. Dis., 72, 1943, 142-153; Lush and Burnet, Austral. Jour Exp. Biol and Med. Sci., 15, 1937, 375-383; Magill and Francis, Brit. Jour Eap. Path , 19, 1938, 273-284; Nigg et al, Am. Jour. Hyg., 34 (B), 1941, 138-147; Orcutt and Shope, Jour. Exp. Med., 62, 1935, 823-826; Rosenbusch and Shope, abid., 69, 1939, 499-505; Shope, abid., 69, 1934, 201-211; 62, 1935, 561-572, 64, 1936, 47-61: 67, 1938, 739-748, 74, 1941, 41-47, 49-68; 77, 1943, 111-126, 127-138; Shope and Francis, thid., 64, 1936, 791-801; Smillie, Am. Jour. Hyg , 11, 1930, 392-398; Smith et al., Lancet, 225, 1933 (2), 66-68, Brit. Jour. Exp Path , 16, 1935, 291-302; Smorodintseff and Ostrovskaya, Jour. Path. and Baet., 44, 1937, 559-560; Stock and Francis, Jour. Exp. Med., 71, 1948. 661-681; Stray's, Jour. Path. and

Dis., 69, 1941, 278-284; Tang, Brit. Jour. Exp. Path., 19, 1933, 179-183; Taylor, (A. R.), et al., Jour. Immunol., Virus Res. and Exp. Chemother., 47, 1943, 261-27, Taylor, (R. M.), et al., Am. Jour. Hyg., 51, 61, 919, 36-45; Jour. Inf Dis., 63, 1941, 90-96; Weils and Brown, Am. Jour. Hyg., 24, 1936, 407-413.

Tarpeia beta spec, nor. From second letter of Greek alphabet.

L.,

mouse, chick embryo.

Geographical distribution: United States, England.

Induced disease: In man, subclinical disease or one resembling that induced by influenza A virus. In chick embryo, experimentally, virus increases in endermal cells lining allantoic cavity.

Scrological relationships: Not neutralized by antiserum to influenza A virus. Specific neutralization and complemenfixation reactions. Rapidly adsorbed by normal chicken-blood red cells [65 per cent in 15 minutes), released in 4 hours essentially completely; the process is then repeatable with fresh red cells.

Other properties: Particle circular or bean-shaped in outline, with average diameter of 97.3 millimerons in electron micrographs; of 99.8 millimierons by centrifugation studies.

Literature Burnet, Austral, Jour. Exp. Biol. and Med. Sci., 18, 1911, 201-205; Francis, Science, 92, 9190, 465-405; Foc. Exp. Biol. and Med., 45, 1910, 561-863; Hirst, Jour. Exp. Med., 76, 1912, 195-208; Lush et al., Brit, Jour. Exp. Path, 93, 1911, 302-301; Nieg et al., Am. Jour. Hyg., 95, 1912, 205-293; Eharpet al., Jour. Immunol., Virus Res. and Exp. Chemother, 48, 1944, 129-153.

3. Tarpela premens spec. nov. From

irus.

L., man. Experimentally, also chimpan-

Geographical distribution: World-wide except in conditions of isolation of small communities

Induced disease In man, incubation period about 48 bours; mild malady; runnine nose in \$1 per cent of cases, obstruction of nostrels in 44 per cent, sudden onset in 37 per cent, cough in 31 per cent, headache in 19 per cent, sore throat in 14 per cent, fever in 13 per cent, inflammation of eyes in 12 per cent; changes in weather, especially during a warm season. predispose to the disease, no correlation between susceptibility and outdoor exererse, exposure to fresh air while electing. eve color, adenotonsillectomy, or size of frontal sinus. Incidence inversely proportional to daily hours of sunshine and atmospheric temperature. Fitness (defined by speed of avvgen replacement) correlated with relative freedom from colds Effect of rest during disease favorable, reducing complications, length of fever, duration of illness, and period off duty

Immunological relationships: After attack, specific immunity for about 7 weeks (minimum period 23 days), then exposure to chilling may cause a relapse, but an isolated community tends to lose the young during the refractory period

Pilterability Passes Berkefeld V and

Other properties Viable at least 13 days at ice box temperature, anaecobically, at least 4 months from and distributed in rocco. Gum accord tends to stabilize virus in chick-embryo tissue medium.

Literature Docher et al., Jour. Esp. Med., 63, 1936, 529-579, Douill et al., Am. Jour. Hyg., 13, 1931, 469-477, J7. 1933, 526-561, Gafaler, thid., 13, 1931, 771-70, 16, 1932, 233-210, 549-545, Jour. Inf. Div., 51, 1932, 193-203, Gafafer and Douill, Am. Jour. Hyg., 18, 1933, 712-726, Richard and Chapman, 1944, 55, 1937, 116-123, Linceland et al., Proc. Soc. Esp. Biod. and Med., 55, 1952, 513-215, Let.

Blanc and Welborn, Am. Jour. Hyg., 24, 1936, 19-24; Locke, Jour. Inf. Dis., 60, 1937, 106-112; Long and Boull, Proc. Soc. Lxp. Biol. and Med., 28, 1930, 33-35 Maughan and Smiley, Am. Jour. Hyg., 9 1929, 469-472; Noble and Brainard, Jour. Bett., 29, 1933, 407-409, Palmer, Am. Jour. Hyg., 10, 1932, 221-232, Paul and Freese, 45rd, 17, 1933, 517-555; Shibley et al., Jour. Am. Med. Assoc., 53, 1930, 1533-1556; Smiley, Am. Jour. Hyg., 6, 1952, 247-479.

4. Tarpela fells spec. nov. From Latin feles, cat

Common name Yeline-distemper

Hosta, FELIDAE—Fela catus L, demestic cat, F, pardus, leopard; F, tigrion, American tiger cat, F, aurata, African tager cat; F, planuceps, rusty tiger cat; F, mermorata, marbled cat; F, caracal, caracal lynx; F, pardains, ocelot; lion, tiger, puma relatively unsuscentible.

Insusceptible species Man, dog, ferret, mongeose, rabbit, rat, mouse, guinea pig.

Induced disease In domestic cat. coughing, sneezing, running eyes and nose, with serous or purulent conjunctivitas, or diarrhea and somiting, fever to 103 or 105° F; loss of appetite, general weakness, mortality high, especially among young individuals, death usually occurs on the 10th to the 12th day, in extreme cases, however, as early as the 5th or as late as the 35th day, catarrhal congestion in some part of the gastrointestinal tract is typical, this ranges from a few small patches in the ileum to involvement of the whole small intertine and parts of the large intestine or stomach and esophagus, often enlarcement and congestion of abdominal lymph glands, enlargement of spicen, pleurisy, and perstonitis

Filterability Passes Perkeleld N and Chamberland L. filters.

Transmission By famile s. Immunological relationships: Recovered cata specifically immune. Other properties: Viable at least 3 weeks in 50 per cent glycerine; attenuated or killed by drying at room temperature, but some immunization is reported if dried virus is injected.

Literature: Dalling, Vet. Record, 15, 1935, 283-293; Findlay, Vet. Jour., 89, 1933, 17-20; Hindle and Findlay, Jour. Comp. Path. and Therap., 45, 1932, 11-28; Verge and Cristoforoni, Compt. rend. Soc. Biol., Paris, 99, 1928, 312-314.

## 5. Tarpela vitulae apec. nov. From Latin vitula, cow-calf.

Common name: Pneumoenteritis virus
Hosts: BOVIDAE—Bos taurus L., domestic cattle. Experimentally, also
MURIDAE—Mus musculus L., mouse.
Geographical distribution: United

States.

Induced disease: In cattle (calves), after incubation period of 2 to 4 days, fever increasing rapidly to 40 or 41° C and lasting 3 to 5 days; usually after first day of fever, diarrhea with feces soft, yellow, voluminous, fetid in odor, occasionally blood-tinged or flud; diarrhea is followed by pneumonia and recovery after disappearance of fever; catarrhal enteritis and a bronchopneumonia usually confined to the anterior lobes of the lungs underline the symptoms, no inclusion bodies in cells of affected tissues.

Transmission. By pen contacts with infected caives. Experimentally, by intransal inoculation of ealers, using incoula prepared from lungs of infected mice.

Serological relationships Recovered animals develop neutralizing antibodies.

Immunological relationships: A specific resistance to reinfection is conferred by an attack of the disease.

Filterability: Passes Berkefeld N filter. Literature: Baker, Cornell Vet., 33, 1942, 202-204; Jour. Exp. Med 78, 1943, 435-446.

6. Tarpeia canis spec. nov. From Latin canis, dog. Common name: Canine-distemper virus.

Hosts: CANIDAE—Canis familiaris L., dog; Vulpes sp., fox. MUSTELL-DAE—ferret.

Insusceptible species: Man, rabbit, guinea pig, white rat, cat.

Geographical distribution: Widespread throughout the world.

Induced disease: In dog, after 4 days from time of infection, fever and a watery discharge from the eyes and nose, sometimes inconspicuous but often profuse; usually diarrhea and wasting followed by recovery or, exceptionally, death. Virus passes from the respiratory tract through the blood stream to its favored sites m vascular endothelium and cells of the reticulo-endothelium and cells of the individual cells in the same and intestine, and bile-duct epithelial cells, there are also cytoplasmi inclusions in bile-duct epithelial cells.

Transmission: By contact. Probably by air-borne droplets. No arthropod vector is recognized.

Immunological relationships: Deadvaccine treatment followed by livingvirus treatment produces a lasting immunity. Virus inactivated by photodynamic effect in 2 mm layer of 1:50,000 or 1:100,900 methylene blue, exposed 30 minutes at 20 cm from 100 candle-power lamp, still immunizes. Vaccine may be drued.

Filterability · Passes Chamberland la and Mandler filters.

other properties 'Viable in liver tissue at 10° C for 35, not 85, days; in glycerine-saline solution at 10° C, 67 days though deteriorated, in vacuum-dried liver tissue, at 10° C, 90 days. If dried from frozen state, virus is viable in vacuum at least 480 days at 7° C, in oxygen-free nitrogen at least 385 days at 7° C. Viable in 25 per cent sterile horse serum at -21° C more than 693 days.

Literature Carré, Compt. rend. Acad. Sci., Paris, 140, 1905, 689-690; Dalldorf, Jour. Evp. Med., 70, 1939, 19-27, De Monbreun, Am. Jour. Path, 18, 1937, 167-212; Dunkin and Laidlaw, Jour. Comp. Path. and Therap., 39, 1926, 201-212, 213-221; Green and Evans, Am. Jour. Hyg., 29 (B), 1939, 73-87; Laidlaw and Dunkin, Jour. Comp. Path. and Therap., 39, 1936, 222-230; 44, 1928, 1-17, 297-227. Perdrau and Todd, ibid., 46, 1933, 78-89, Spedentopf and Green, Jour. Int. Dis., 71, 1942, 233-239; Whertron and Wharton, Am. Jour. Hyg., 19, 1934, 199-216

7. Tarpela vulpis spec. nor. I'mm Latin sulpes, fox.

Common name Fox-encephalitis virus Hosts CANIDAE-Vulpes sp , silver fox Experimentally, also some, but not all, dors, coyote.

Insusceptible species Gray for, mink, ferret, sheep, laboratory rabbit.

Geographical distribution United

Induced disease. In fox. after 2 days from time of infection, loss of appetite. shold mard discharge; convulsions with early death or hyperexentability, blind walking lethares, flacendor smatte naralsas, muscular twitching, fearfulness, weakness, coma and death, many more force become infected an enizootics than show obvious disease, some being symptomless carners, 12 to 20 per cent fatals ties may be experienced among young foxes on ranches, 3 to 9 per cent among adults. Intrapuelear inclusions in vascu for enclothelial cells especially in cerebral endathelium, sometimes in hepatic cells and enduticint cells of liver and kidnes . to intract topi senie inclusions, timis in beart blood spicen, and brain, in carriers. strus is believed to persist in focal lesions in upper respiratory tract. Experimen tally to susceptible does, sometimes coryra, discharge from eyes and nose often purulent, commonly fits of excite ment, coma, death, recovery rare, cellular infiltration in the central persons six. tem, local necessia of the liver, specific

intranuclear inclusions in cells of the vascular endothelium, meningcal cells, reticulo-endothelium, hepatic cells, and occasionally in cortical cells of the adrenal.

Transmission. Experimentally, by akin scartification, intramuscular injection, incutation of crysterna, intratesticular injection, inoculation of nesal cavity; not by corneal scarification.

Immunological relationships: Injections of this virus afford no immunity to subsequent infection by canine distemper virus.

Filterability: Passes Berkefeld N filter. Other properties: Viable in 50 per cent glycerine for several years, in carenas for several days.

Literature Barton and Green, Am. Jour Hyg., 57, 1943, 21-36, Green, Proc. Soc. Exp. Biol. and Med., 28, 1923, 677-678, Am. Jour. Hyg., 13, 1931, 294-223, Green and Dewey, Proc. Soc. Exp. Biol. and Med., 27, 1929, 129-130; Green and Evane, Am. Jour. Hyg., 29 (B), 1939, 73-87, Green and Shillinger, 194d, 19, 1934, 302-391, Green et al., 1946, 12, 1935, 362-391, 41, 1931, 33-351, 16, 1933, 462-481, 19, 1931, 343-361, 21, 1935, 366-388, 24, 1936, 57-70, Lucas, Am. Jour. Puth. 16, 1940, 737-760.

S Tarpela vivertae spec nor. From Latin riverra, ferret.

Common name Ferret-distemper

Host MUSTELIDAE-Musicla furo.

Insusceptible species. Dog. mouse, rat, guinea pig, rabbit.

Geographical distribution United States.

Induced disease In ferret, fever to 105 or 105 °F, lettlargs, loss of appetite, conjunctivitis with exidate closing e.jes, sometimes a purulant masal disefeater, weight loss small, succing rare, difficulty in breathing, deth 14 to 50 days after moculation (average 20 days), sometimes

preceded by convulsions and other nervous signs; fatality rate 70 to 100 per cent.

Transmission: By cage contacts. By feeding. Experimentally by intranasal, subcutaneous, or intradermal inoculation.

Immunological relationships: In immunized animals, no cross immunity with canine distemper virus nor with human influenza virus.

Thermal inactivation: At 60° C in 30 minutes.

Filterability: Passes Berkefeld N filter. Other properties: Viable at least 3, but not 5, months in 50 per cent neutral glycerine; at least 4 months when frozen and dried in vacuo.

Literature: Slanetz and Smetana, Jour. Exp. Med., 66, 1937, 653-666; Spooner, Jour. Hyg., 38, 1938, 79-80.

9. Tarpeia avium spec. nov. From Latin aves, fowl of the air.

Common names: Laryngotracheitis virus; also known as infectious laryngotracheitis virus and as infectious bronchitis virus.

Hosts: PHASIANIDAE—Gallus gallus (L.), chicken. Experimentally, also PHASIANIDAE—pheasant; F, hybrid between male Ringneck pheasant and female bantam chicken; choricallantoic membrane of developing chicken embryo (with macroscopic lesions on membrane as a result of proliterative and necrotic changes); turkey embryo

Insusceptible species: Guinea fowl (no evidence of discase on inoculation); white rat, guinea pig, rabbit; embryos of pigeon, ruinea fowl, and duck.

Geographical distribution United States, Canada, Australia.

noss of appears, name, both eyes, respiratory distress, hemorrhagic and nucous exudate in lumen of trachea and occasionally in the bronchi; death as a result of asphyxiation or, more often, recovery, recovered birds occasionally carry the virus in the upper respiratory tract for some time (a period of 407 days has been recorded); virus is not found on eggs during an outbreak in a flock, but is always in trachea of an affected bird; intranuclear inclusions in trachea lesions; virus has special affinity for mucous membrane of eye, nostri, larynx, trachea, cloaca, and burss of Fabricius; susually affects more than half the birds in a flock, with a mortality of 5 to 60 per cent (averaging between 10 and 20 per cent).

Transmission: By contacts, Experimentally, by intrabursal injection (in bursa of Fabricius) or by rubbing the mucous membrane in the dorsal region of the outer or proctodeal part of the class with a small cotton swab moistened with a suspension of virus.

Serological relationships: Serum from recovered fowl neutralizes virus; dilution tends to reactivate neutralized virus.

Immunological relationships: Experimental infection of cloaca and burss of Fabricius, especially in 2 to 4-month-old birds, immunizes against infection by subsequent trached inoculation.

Thermal inactivation: At 55.5° C in 10 to 15 minutes; at 60° C in 2 to 3 minutes; at 75° C in ½ to ½ minute; all tests with virus in the presence of tracheal exudate. Filterability: Passes Berkefeld V and

N filters. Strains: A Victorian strain has been re-

ported as of low virule.ce for fords.

Other properties: Exactivated in 5 per cent phenol in 1 minute; in 3 per cent eresol compound in 3 minute, in 1 per cent sodium hydroxide in 4 minute. Viable in tracheal fluid in dark for 75, not 110, days; in light for 6, not 7, hours; in buffer soliton at pH 7.4 for 131 days; at 4 to 10° C in dark for at least 631 days. Viable in dead body at 37° C for 23, not 44, hours; at 13 to 23° C for 10, not 15, days; at 4 to 10° C for 30, not 60, days.

t Literature: Beach, Science, 72, 1930, 633-634; Jour. Exp. Med., 54, 1931, 803-816; Jour. Inf. Dis., 57, 1935, 133-135;

52. Pseudomonas membranoformis (Zobell and Allen) Zobell. (Achromobacter membranoformis Zobell and Allen. Jour. Bact., 29, 1935, 246, Zobell, Jour Bact., 46, 1943, 45) From Latin membrang, membrane, and forma having the form of.

Rods: 09 to 1.2 by 3.5 to 48 microns, occurring singly and in pairs. Motile with lophotrichous flagella Encapsulated. Gram-negative

Gelatin stab: Growth filiform, best at top, with slow crateriform liquefaction Agar colonies: Circular, 10 to 25 mm,

with crinkled surface.

Agar slant: Moderate, beaded, raised growth. Membranous consistency Becomes browned with age.

Broth · Slight turbidity, flocculent sediment, film of growth on walls of test tube

Milk: No growth.

Potato: No growth.

Indole not formed. Nitrites not produced from nitrates.

No H.S produced.

Acid but not gas from glucose, sucrose, devtrin and mannitol. No acid from lactose or xvlose.

No diastatic action.

Optimum temperature 20° to 25°C.

Aerobic. Source: Sea water

Habitat : Sea nater.

marinoglutinosa 53. Pseudomonas (Zobell and Allen) Zobell. (Achromobacter marinoglutinosus Zobell and Allen, Jour. Bact , 29, 1935, 246; Zobell, Jour. Bact , 46, 1943, 45). From Latin marinus, pertaining to the sea, and glutinosus, full of glue, sticky

Short rods. 0.7 to 1.0 by 1.8 to 2.4 microns, with rounded ends, occurring singly, in pairs and in clumps. Motile with polar flagella Staining granular.

pigment Agar colonies: Round with concentrie circles and crinkled radial lines, 1.5 to 50 mm in diameter. No nument. Agar slant. Moderate, filiform, flat

Butyrous consistency. Broth: Moderate clouding, marked

ring, adherent film of growth on test tube wall, and flaky sediment.

Milk: No growth. Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates Hydrogen sulfide and ammonia produced from Bacto-tryptone.

Acid but not gas from xylose and dextrin. No acid from glucose, lactose, sucrose and mannitol.

Starch is hydrolyzed.

Optimum temperature 20° to 25°C.

Aerobic, facultative Source Sea water.

Habitat: Sea water.

54. Pseudomonas gelatica (Gran) Bergev et al (Bacillus gelaticus Gran. Bergens Museums Aarbog, 1902, 14; Bacterium gelaticum Lundestad, Cent. f. Bakt., II Abt., 75, 1928, 328; Bergey et al . Manual, 3rd ed . 1930, 175.) From French, like relatin

Rods, with rounded ends, 0.6 to 1.2 by 1 2 to 26 microns, occurring singly, in pairs, and sometimes in short chains. Motile. Gram-negative.

Fish-gelatin colonies: Circular, transparent, glistening, becoming brownish in

Fish-gelatin stab: Liquefaction infundibuliform, with greenish color.

Sea-weed agar colonies. Circular, flat, entire, glistening, reddish-brown center with grayish-white periphery, Lique-

Fish-agar slant: Flat, transparent streak, with undulate margin, reddishbron n.

Broth, Turbid with flocculent pellicle. and greenish-yellow sediment.

Indole not formed.

Nitrites are produced from nitrates. Starch hydrolyzed.

in minced swine testicle on solid serumagar and on egg membrane, increase being limited to the living tissues from the swine and furnishing inoculum active in amounts as small as 10<sup>-2</sup> ml.

Transmission: By feeding. Through air contamination. Rarely by contact. Experimentally, by subcutaneous injection. Urine highly infective. Virus in blood and all tissues early in disease.

Serological relationships: Immune serum affords passive protection.

Thermal inactivation: At 55° C in 30 minutes; at 60° C in 10 minutes. At 72° C in 1 hour in dried blood.

Filtersbillity: Passes Berkefeld filter.
Other properties: Viable in blood in
cool, dark place at least 6 years.

Literature. De Kock et al., Onderstepoort Jour. Vet. Sci. and Anim. Indust., 14, 1910, 31-93; Hecke, Cent. f. Bakt., I Abt., Orig., 196, 1932, 517-529; Montgomery, Jour. Comp. Path. and Therap. 34, 1921, 155-191; Röhrer, Arch. Tierheilk., 62, 1930, 345-372, 439-462; 64, 1931, 124-143, TenBroeck, Jour. Evp. Med., 74, 1941, 427-432.

Tortor bovis spec. nov. From Latin bos, cow.

Common names Cattle-plague virus, virus of pestis bovina, runderpest virus, Rinderpest virus,

Hosts · BOVIDAE—Bos taurus L., domestic cattle; swine, buffalo, zebu cattle, sheep, goat, camel, deer. Koedoe, eland, bushbuck, dulker, and other antelopes.

Insusceptible species Man, solipeds, carnivora.

Geographical distribution. Widespread over Asia and the Asiatic islands. At times in Western Europe. Enzociteally in Turkey. Periodically in North Africa. Sepecially in Egypt; at times throughout Africa. Not in North America. At times in South America, Australia (suppressed quickly).

Induced disease. In domestic cattle, after 3 to 9 days, febrile reaction, restlessness, loss of appetite, cessation of rumina-

tion; fever highest at 5th or 6th day of disease, then temperature drops to normal or subnormal and diarrhea begins; muzzle dry, coat staring, hair dull, skin moist in parts; twitching of superficial muscles. grinding of teeth, arching of back, plairy discharge from nose, redness of mucous membranes: restlessness increases, durrhea becomes severe with fetid, bloodstained or blackish liquid discharges: weakness, drooping of ears, occasional yanning, coldness of extremities; occasionally excitement precedes weakness: skin may become red and moist, showing protuberances and vesicles, with matted hair; later wrinkling and scab formation; conjunctiva red, eyelids awollen, tears flowing, followed by mucous, then purulent, discharge; sometimes a cough develops and respirations become rapid: red spots inside mouth develop into erosions or ulcers, often confluent; pregnant animals often abort: milk of cows decreases, sometimes becoming yellow and watery. Death is sometimes early (1 to 2 days after first manifestations of discase), more often delayed (4 to 7 days); sometimes animals live 2 or 3 weeks or longer. Disease milder and more chronic where enzootic; morbidity to 100 per cent and mortality to 96 per cent in new areas. Recovered animals show a lasting, sterile mmunity. Urine, feces, nasal and lachrymal discharges, sweat, aqueous humour, cerebrospinal fluid, lymph, emulsions of viscera and muscles, and blood are infective during the course of the disease.

Transmission. By contact, even during prodromal period; by contaminated food, troughs, or other articles. No insect vector is known.

Immunological relationships One attack confers a lasting immunity, exept rarely, when a mild second attack may occur. A calf from a diseased mother may be resistant if pregnancy was advanced when the disease occurred.

Filterability: Passes Berkefeld V filter candle, with difficulty.

Other properties: Remains infective at

Beach et al , Poultry Science, 15, 1934, 198-20; Reaudette and Hudson, Science, 76, 1932, 31; Jour. Am. Vet. Med. Assoc., 85 (N.S. 55), 1933, 460-476; 95, 1939, 333-339; Brandly, 1646, 88 (N.S. 47), 1936, 597-696; Jour. Inf. Dis., 57, 1933, 201-206; Brandly and Bushmell, Foultry Science, 15, 1934, 212-217; Burnet, Brit. Jour. Exp. Path., 15, 1931, 52-85, Jour. Exp. Austral Jour. Exp. Brit. Jour. Exp. Austral Jour. Exp. Brit. And Med. Sec., 19, 1911, 235-210, Gibbs, Jour. Am. Vet Med. Assoc., 81, (N.S. 55), 1932, 631-651, Masschusetts 4g. Exp. Sci., 159, 193.

Bull. 295, 1933, bidd., Bull. 311, 1931; Hinshaw et al., Poultry Science, 10, 1931, 375-352; Hudson and Beaudette, Science, 76, 1932, 31; Cornell Vet., 22, 1932, 70-74; Kernohan, California Agr. Exp. Sta., Bull. 494, 1930, 3-22; Jour. Am. Vet. Med. Assoc., 78 (N. S. 31), 1931, 553-555; Komarov and Beaudette, Poultry Science, 11, 1932, 323-333; May and Tittsler, Jour. Am Vet. Med. Assoc., 67, (N. S 20), 1925, 229-231, Schlam and Beach, Jour. Inf. Dis., 56, 1935, 210-223; Scifried, Jour. Exp. Med., 44, 1931, ST-825.

### Genus III. Tortor gen. nov.

Viruses of the Hog-Cholera Group inducing diseases characterized by involvement of many tissues. Generic name from Latin forter, termentor.

The type species is Tortor suis spec. nov.

#### Key to the species of genus Tortor.

- I in mammals.
  - A. Infecting swine.
  - B Infecting cattle.
  - C Infecting the horse.

  - D Infecting sheep
- C. Infecting est
- II In birds

- 1. Toriot se i
- 2. Tortor bours.
- 3. Tartor equarum
- 4. Tortor equa.
- 5. Tertor ores.
- 6. Tortor felis
- 7. Tertor galls.
- 8. Tortor Jurens

 Tortor suls spec. nor. From Latin sus, hog.
 Common names Hog-cholera virus,

some fever virus

Host SUIDAE—Sus scrofa L., domestic same Warther (symptomless

carrier).

Insusceptible species. Dog. rat. cow. horse, donkey, sheep, gost, rabbit, guines pig, mouse, rat. goose, hen, duck, pigeon Geographical distribution. Almost universal in pig breding countries, espe

easily in Europe, the British Isles, North and South America.

Induced disease In some, after intramuscular injection, increased temperature and prostration within 23 to 3 days; later lymph nodes enlarged, sometimes hemorrhage, homorrhages under capsule of kadneys. Virus may remain in blood of eccovered pigs for 10 months. Acquired immunity is lasting, but most naturally infected animals die in newly infected beriak. Virus has been cultured

Africa.

Literature: Alexander, Onderstepoort Jour. Vet. Sci. and Anim. Indust., 4. 1935, 291-322, 323-348, 349-377, 379-388; 7, 1936, 11-16; 11, 1938, 9-19; Alexander and DuToit, toid., 2, 1934, 375-391; Alexander and Mason, ibid., 16, 1911. 19-32; Alexander et al., ibid., 7, 1936. 17-30; DuToit et al., ibid., 1, 1933, 21-21, 25-50; Henning, in Animal Diseases in South Africa, Central News Agency, Limited, South Africa, 2, 1932, 516-538; M'Fadyean, Jour. Comp. Path. and Therap., 15, 1900, 1-20; 23, 1910, 27-33, 325-328; Nieschulz and DuToit, Onderstepoort Jour. Vet. Med. and Anim. Indust., 8, 1937, 213-268; Polson, ibid., 16, 1941, 33-50, 51-66; Nature, 148, 1911, 593-591; Theiler, Deutsch, tierarztl. Weehenschr., 9, 1901, 201-203, 221-226, 233-237, 241-242; Report for 1905-1906 of the Govt. Veterinary Bacteriologist. Transvaal Dept. Agr., 1907, 160-162; Jour. Comp. Path, and Therap., 23, 1910. 315 - 325.

4. Tortor equae spec. nov. From Latin equa, mare.

Common name. Mare abortion virus.

Hosts: EQUIDAE—Equus caballus

L., horse. Experimentally, also Syrian
hamster (newborn); tissues of human
placenta grafted on the choricallantois of
the chick embryo.

Insusceptible species: Chicken (embryo; no observed susceptibility).

Induced disease. In horse, small, multiple, grayish white areas of necrosis in the livers of aborted fetuses, acidophilic intranuclear inclusions in hepatic cells around these foci, in epithelial cells of bile ducts, and in bronchial epithelium, petechial hemorrhages in the heart, spleen, and lungs; excess fluid in the thoracic cavity.

Transmission: By contact. By living in contaminated stalls.

Literature: Anderson and Goodpasture, Am. Jour. Path, 18, 1942, 555-561; Dimock, Jour. Am. Vet. Med. Assoc., 96, 1940, 665-666; Dimock and Edwards, Cornell Vet., 26, 1936, 231-240; Goodpasture and Anderson, Am. Jour. Path., 18, 1942, 563-575; Hupbauer, Münch. Tierārztl. Wchnschr., 89, 1938, 37-38; Miessner and Harms, Deutsche Tierāriii. Wchaschr., 49, 1933, 745-748.

5. Tortor ovis spec. nov. From Latin ovis, sheep.

Common name: Biue-tongue virus
Hosts: BOVIDAE—Ovis aries L.,
sheep; Bos taurus L., cattle.
Geographical distribution: South

Induced disease : Both sheep and cattle may carry the virus at times without obvious manifestations of disease or there may be severe manifestations. In sheep, experimentally, diffuse hyperemia of buccal mucosa, especially of lips; then petechiae and ecchymoses followed by excoriations and necrosis of the mucous membrane, especially on lips, tongue, inside of cheeks, dental pad, gums, muzzle, and external nares; sometimes deep seated necrotic ulcers on tongue developing from the more usual superficial necrotic process; mucoid discharge from nostrils, becoming muco-hemorrhagic; commonly frothing at the mouth in early stages of the disease; frequently reddening of skin of lips and nose; rarely whole skin becomes flushed and wool is shed; often swelling of vulva with necrotic changes on borders and petechiae in mucosa; tongue sometimes awollen; lameness common and severe; recovery or 'ha: death. In eattle, edema of lips and tongue; hyperemia of oral mucosa; multiple hemorrhages in skin, lips, mucous membrane of the lips, tongue, dental pad, buccal cavity, small intestine, myocardium, epicardium, and endocardium, less frequently in the traches, nasal cavity, bladder, urethra, pulmonery artery, and pleura, localized necrotic areas followed by ulceration on lips, gums, the dental pad, tongue, mucous membrane of the rumen, pylorus of the stomach, and the external nares; scattered skin lesions with reddening, slight exudation, crusting, sloughing of crusts and hair together,

least 2 weeks at 0° C in virulent blood, less than 2 days in hides drued in direct samlight, 3 days in contaminated wool, as long as 12 days in meat; is inactivated by glycerine, blue, chloroform, formalin, and 2 per cent plucool, is virulent at least 26 days in body of feech, Hurudo boyntom Wharton (HIRUDIDAE), fed on such animal.

Literature: Boyaton, Philippine Agr. Rev., 10, 1917, 410-433, Daubney, Jour. Comp Path and Therap., 41, 1928, 228-218, 223-297, Hornby, ibid., 41, 1928, 17-21; Pfaff, Onderstepoort Jour Vet. Sci and Anim Indust., 11, 1938, 263-330; 16, 1910, 175-184; Weston, Jour Am Vet. Med. Assoc., 66 (N.S. 19, 1921, 337-330).

# 3 Tortor equorum spec. nov From

Common names Horse-sickness virus, African horse sickness virus, virus of pestis equorum, virus of perdesickte, virus of South Miscan Pferdesterbe.

Hosta EQUIDAE—Equas caballus L, hore, perchapa E structa L, danke, Experimentally, also CANIDAE—Camis familiaria L, dog CANIDAE—Caris porcellus L), guinea pig MCRIDAE—Ratius norvegicus (Grubelen), wild and albipo rat, punice, Angusi agust, Mustamys coucha, multimammate mouse, Tatera loberguda, gerbille, cirick embryo (but no virus in hat field clirick). Mule and rebra relatively resistant.

Insusceptible species HOMINIDAE

- Homo sapiens L., man. LEPORI
DAE-Arytologus cunteulus (L.), rabbit
ton obsert ed discare)

too observed disease)

Geographical distribution. Mrica, especially in constal regions and inver-

valleys

Induced disease in the borse, four types of disease are recognized. Horse-suckness fever, producinal period 5 to 25 days, use of body temperature to 105° F in 1 to 3 days, with return to mental temperatures in another day or twi, minetims I see of appetite, reduces of conjunctive little disease, and then disease, and the superatures at them directing, and a

celerated pulse; recovery prompt, Dunkop or neute pulmonary horse-sickness, prodromal period of 3 to 5 days, severe dyspace, fever, couching, frothing at nostrils, fever to 106° F, breathing rate to 60 a minute, nostrils dilated, head and neck extended, rare drooping, sweating, progressive weakness; often fatal. Dikkon, or cardiac form of borse-sickness. prodromal period 5 to 21 days, fever develops slowly, lasts long; edematous swellings of head and neck, symptoms of cardiac dyspnea, sometimes blood spots on conjunctiva, mucous membranes of mouth and tongue bluish, restlessness; sometimes fatal outcome. Mixed form of horse-sickness, combining features of pulmonary and cardiac types. Horses recovering from natural infections are known as "salted" and possess beightened resistance to the disease.

Transmission Not by contact. Mosquitoes and biting flies have been suspected as vectors. Experimentally, by intravenous or subcutaneous injection.

Serological relationships Serologically distinguishable strains exist

Immunological relationships Immunity to homologius strain complete after an attark (horse then known na "kalted" for that strain), but immunity to beternlogius strains incomplete. Antibodies absent from young at birth but as high in titer as in dim within 30 hours, presumably from colostral milk; declining graduulty over a period of about 6 months.

Thermal mactivation At 57.5 to 60° C in 10 minutes.

Patternhality Passes Berkefeld, Chamberland F, and Senz UK filters.

Other properties Visible dry at least 15 months Stable in alkaline solutions (to pH 10), unstable in acid (beyond pH 6 0). Serum salme solutions preferable to salme solutions for atorage. Particle diameter determined as 40 to 60 millimicrons (mean 50 millimicrons) by fiftration included, 45 f millimicrons by centrifuging Denoity 1,25 gm her mi.

lewlectric paint at fell 1 %.

and seek shade, drooping of wings and tail; cyes closed or partly closed; some dyspnex; in some cases, edema of head and neck; in late stages, sometimes cyanosis of comb and skin; staggering, twitching, or spasms; fever may disappear and temperature become subnormablefore death; recovery in about 30 per cent of all cases; linear and punctiform hemorphages throughout body.

Transmission: Method of natural transmission unknown. The fowl louse, Gonicated stissmills (PHILOPTERIDAE), has been suspected as vector (Maggiora and Tombolato, Rendiconti, Aceademia delle Science dell'Instituto di Bologna, n.s. 27, 1923, 200-203). Experimentally, by subcutaneous, intramuscular, and intravenous iniection.

Serological relationships: Specific neutralizing antiserum does not react with influenza virus. No reaction of fowlplague virus with antisera specific for canine distemper, influenza, or Rift Valley fever viruses.

Thermal inactivation: At 55° C in 1 hour in whole blood or brain.

Filterability Passes membrane of average pore diameter 150, not 100, not ordinarily 125, millimicrons. Passes Berkefeld and Chamberland filters

Other proporties: Particle diameter estimated by filtration as 60 to 90 millim-crons; by centrifugation, as 120 to 130 millimicrons. Viable after exposure in 1:0,000 dilution for 10 minutes, in 2 mm layer of 1:50,000 methylene blue, 15 cm from a 300 candle-power filament lamp Withstands drying. Precupitates from salt-free solutions or in presence of half-saturated ammonium sulphate solutions, virus held to be of globulin nature by Mrowka, Cent. f. Bakt., 1 Abt., Orig., 67, 1912, 243–263.

Strains Variant strains have been produced by intracerebral passage in brains of canaries and mice.

Literature Bechnold and Schlesinger, Biochem. Ztschr, 236, 1931, 397-414; Ztschr. Hyg. Infektionskr., 112, 1931, 668-679; Burnet and Ferry, Brit. Jour. Exp. Path., 15, 1934, 56-64; Centann, Cent. f. Bakt., I Abt., Orig., 31, 1902, 145-152, 182-201; Elford and Todd, Brit. Jour. Exp. Path., 14, 1933, 240-246; Findlay and Mackenzie, ibid., 18, 1937, 146-155, 258-264; Findlay et al., Jour. Path. and Bact., 45, 1937, 589-596; Lépine Compt. rend. Soc. Biol., Paris, 191, 1938, 509-510; Mackenzie and Findlay, Brit. Jour. Exp. Path., 18, 1937, 138-145, Nieschulz and Bos. Cent., Bakt., IAbt., Orig., 131, 1931, 1-6; Plotz and Haber, Compt. rend. Soc. Biol., Paris, 125, 1937, 339-349.

8. Tortor furens spec. nov. From Latin furere, to rage.

Common name: Newcastle-disease virus.

Hosts: PHASIANIDAE—Gallus gallus (L.), domestic chicken. HOMINI-DAE—Homo sapiens L., man (by laberstory accident). Experimentally, also pigeon; chick embryo (with primary lessons and cytopiasmic inclusions in choricallantic membrane)

Geographical distribution England, probably also East Indies, Ikorea, Japan,

India, Australia.

Induced disease: In chicken, acute, febrile, highly contagious, usually fatal disease resembling four lague; loss of appetite, crouching attitude, half closed eyes, rapid respirations, wakry yellowish-white diarrhea with nay rating down death usually between 6th and 8th day. In man, accidentally infected in laboratory by virus sprayed info eye, virus recoverable from temporarily inflamed eye, recovery in 8 days with gradual increase of specific antibodies in blood.

Transmission: By contact between healthy and diseased birds.

Serological relationships Antiserum effective in neutralizing homologous virus.

Immunological relationships: Chickens immune to infection by fowl-plague virus are susceptible to infection by this virus

mucoid or mucopurulent discharge from . nostrils: prognosis favorable in mild cases, but disease occasionally terminates with death

Transmission: Not by contact; arthroped vector suspected.

Other properties: Infective particle calculated to be 87 to 105 millimicrons in diameter by sedimentation studies, 100 to 132 millimicrons in diameter by ultrafiltration

Literature: Bekker et al., Onderstepoort Jour. Vet. Sci. and Anim. Indust . 2, 1934, 393-507; De Kock et al., 1bid . 8, 1937, 129-180; Henning, in Henning, M. W., Animal Diseases in South Africa, Central News Agency, Ltd., South Africa, 1932, vol. 2, chapter 27, pages 503-515; Mason and Neitz, Onderstepoort Jour. Vet. Sci. and Anim. Indust , 15, 1940, 149-157; Nieschulz et al , toid , £, 1934, 509-562; Polson, Nature, 148, 1941, 593-594.

6. Tortor felis spec. nov. From Latin feles, cat,

Common names. Panleucopenia virus, infectious felice agranulocytosis virus, infectious aleu ocytosis virus, feline enteritis viri.

Host: FELIDAY - Telis catus L , do-

mestic caf

Insusceitable pecies White mouse, guinea pit somestic rabbit, ferret, Citellus repardsonis (Sabine), ground equire].

Geographical Umted distribution

States, Germiday

Induced disease In cat, variable eflects, some lideviduals little affected others listless recumbent, refusing food, showing some vomiting, diarrhea, nasal and ocular discharges, aften death, after a few minutes of fibrillary twitching and terminal choic convulsions, before there is much best of weight, cometimes recor ery with return of appetite Profound hewopens and marked relative is mphocyven without thrombopenis or appreci alle anema; proliferation of reticulotakthelal cells of lymph nodes and

spleen; intranuclear inclusion in cells of eastro-intestinal mucosa, spleen, lymph nodes, bone marrow, and bronchist mucosa.

Transmission: Perhaps by nasal droplets or contaminated food. No arthropod vector recognized. Experimentally by oral, intragastric, cutancous, subcutaneous, intraperitoneal, intravenous, and intranasal routes.

Serological relationships: Sera from nanleucopenia-immune cats protects against agranulocytosis virus.

Immunological relationships: Cats immune as a result of earlier infection with agranulocytosis virus resist later inocula. tion with papleucopenia virus. Previous inoculation ineffective if made with horcholera virus or fox-encephalitis virus.

Literability, Passes Berkefeld V. N. and W filters and Seitz EK dises.

Other properties: Remains active in 50 per cent glycerine at least 138 days in tissues; not inactivated by drying while frozen, nor by freezing at about ~80° C.

Literature : Hammon and Enders, Jour. Exp. Med. 69, 1939, 327-352; 70, 1939. 557-561; Kikuth et al., Cent. f. Bakt., I Abt . Oriz . 146. 1940. 1-17: Lawrence and Syverton, Proc. Soc Exp. Biol. and Med . 38, 1938, 914-918, Lawrence et al .. Jour. Exp. Med., 77, 1913, 57-61; Am. Jour. Path., 16, 1910, 333-354; Syverton et al . Jour. Exp Med., 77, 1913, 41-56.

7 Tortor galli spec. nor. From Latin oallus, cock.

Common names. Fowl-plague virus. fowl-nest virus.

Hosts Chiefly chicken, turkey, goose, Experimentally, also ferret, thesus monkey, hedgehog, pigeon, duck, canary, mouse, rat, rabbit. Multiplies in embryonated hen's egg, edema, but no discrete primary lesions in choricallantoic membrane.

Geographical distribution: Widespread throughout Europe, North and South America, Asia.

Induced disease: In elicken, loss of appetite, tendency to leave commissions

## FAMILY V. TRIFURACEAE FAM. NOV.

Viruses of the Infectious Anemia Group, inducing diseases mainly characterized by disturbances in balance of blood cells. There is a single genus.

## Genus Trifur gen. nov.

With characters of the family. Generic name from Latin trifur, arrant thief. The type species is Trifur equorum spec, nov.

Key to the species of genus Trifur.

- I Affecting horse.
- II. Affecting fowl.
- 1. Trifur equorum spec. nov. From Latin equus, horse.

Common name: Equine infectious-

Hosts: EQUIDAE—Equus cabellus L., horse; F. asiavas L., donkey. HO-MINIDAE—Homo sapiens L., man. Experimentally, also EQUIDAE—Equus asiava X E. caballus, mule. SUIDAE —Sus except L., swine.

Insusceptible species: BOVIDAE—Bos taurus L, cattle; Ovis aries L., sheep; Capra hircus L., goat. CANI-DAE—Canis familiaris L., dog.

Geographical distribution: Europe, Union of South Africa, United States, Canada, Japan; at times in most parts of the world; not Australia.

Induced disease In horse, progressive anemia with eventual death or chaical recovery and retention of virus; disease may be acute, subacute, or chronic; in acute disease, temperature rise to 104 to 105° F, or even 106 to 107° F, remaining high much of the time until death or change to subscute or chronic form; in the acute form of the disease there is dullness, decreased appetite, drooping of head, flexing of limb not supporting weight; sometimes increase in pulse frequency to 70 or even 100 a minute but oftener rates around 50 a minute; conjunctiva sometimes colored orange, with injection of vessels and petechiae, later becoming muddy colored or pale red, membrane edematous; uncertain mit,

- 1. Trifur equorum,
- 2. Trifur gallinarum.

trailing of hind feet, prostration, sometimes death; subacute disease milder and with remissions; chronic disease still milder, anemia conspicuous, sometimes death from debility or at end of a febrile attack; blood infective long (3 to 7 years) after clinical recovery : urine infective to horse by mouth. In man, diarrhea alternating with constipation, herpes-like exanthema on abdominal wall, blood sometimes in feces; persistent headache, temperature normal; later, lumbar pains, generalized edema, general debility, loss of flesh, pallor of face and mucosae; filtered blood in 1 ml. amount fatal to horse, inducing infectious anemia; improvement after 2 to 4 years. In swine, experimentally, sometimes no outward and obvious signs of disease but blood abnormal and infective; sometimes severe anemia, fever, prostration, loss of appetite.

Thermal inactivation: At 58 to 60° C

in a nour.

Filterability: Passes Berkefeld V filter candle.

Other properties: Viable in blood in citrate saline at -2° C for at least a year. Drying does not inactivate in 10 days but does in 1 month.

Literature: DeKock, Union of South Africa, Dept. of Agr., 9th and 10th Reports for 1923, Pretoria 1924, 223-313; Habersang, Monatshefto für prakt. Tierheilk., 30, 1920, 171-176; Kutsche, bid., 50, 1920, 557-568; Peters, Jour. Am. Vet. and rice rersa. Immunization to this virus does not decrease susceptibility to combor mouth form of fowl pox.

Thermal inactivation: At 60° C in I hour; not at 50° C in 30 minutes. Filterability; Passes Berkefeld, Cham-

berland Ls, and Seitz filters.

Other properties: Particle diameter calculated from filtration experiments to

be 80 to 120 millimicrons. Not inactivated in 30 minutes in 1:50,000 methylene blue solution in 2 mm layer 15 cm from a 300 candle-nower filament lamp.

Succasine-power mament lamp.
Literature Burnet, Med. Jour. Australia, 30, 1943, 313-314; Burnet and Ferry, Brit. Jour. Exp. Path., 15, 1934, 56-64; Doyle, Jour. Comp. Path. and Themp., 40, 1927, 144-169.

## FAMILY VI. RABULACEAE FAM. NOV.

Viruses of the Mumps Group, characterized in general by a special affinity for tissues of the salivary glands. There is a single genus,

## Genus I. Rabula gen. nov.

With characters of the family. Generic name from Latin rabula, pettilogger. The type species is Rabula inflans spec. nov.

Key to species of the genus Rabula.

- I. Affecting man.
- II. Affecting guinea pig.
- III. Affecting hamster.
- IV. Affecting rat.
- V. Affecting mouse.
- 1. Rabula inflans spec. nov. From Latin enflare, to puff up.

Common names. Mumps virus, virus of epidemic parotitis.

L P

Murmany, ....

-Felis catus L., domestic cat.

Geographical distribution: World-wide.

Induced disease: In man, in order of frequency, parotitis, orchitis, meningo-encephalitis, panereatitis, or ovaritis rarely fatal, when parotitis occurs, ones that parotitis occurs ones.

swelling and malase gradually disappearing within a week or 10 days; there is virus in saliva 48 hours after onset; orchitis, less common, is usually unilateral and may be accompanied by some epididymitis. In rhesus monkey, experimentally, acute, non-suppurative parotitis; focal necrosis in acinar epithelial cells of parotid gland, and secondary inflammation; dissemination of lesions within the gland, enlargement of gland to palpation and pitting edema of jowl 6 to 8 days after moculation, often with a rise of tempera-

- 1. Rabula inflans.
- 2. Rabula levis.
- 3. Rabula innocuus.
- 4. Rabula exiguus.
- 5. Rabula latens.

ture; cytoplasmic inclusion bodies affected glands, staining pink, round or oval, 3 to 10 microns in diameter, often vacuolate, usually surrounded by a narrow clear zone in the cytoplasm; blood and uninoculated salivary gland of affected animal not effective sources of virus.

Transmission: Probably by droplets arising directly from infected individuals. Experimentally, by injecting sterile fluids containing virus into Stenson's duct of parotid gland in Macaca mulatia.

Serological relationships: A specific complement-fixing antibody occurs in human and monkey convolescent serum and is demonstrable by the use of monkey-giand antigen.

Immunological relationships: Specific immunity induced by attack; passive immunization rarely successful.

Thermal inactivation: At 55° C in 1 hour.

Filterability: Passes Berkefeld V and N filter candles.

Other properties: Viable in 50 per cent glycerine at 2° C at least 5 weeks, in 50 per cent glycerine at 10° C, at least 7 weeks, dried while frozen at least 7 weeks, in frozen saliva at least 3 weeks. Med. Assoc., 66, 1924, 363-366; Theiler and Kehoc, Union of South Africa, Dept. of Agr., 3rd and 4th Reports of the Director of Veterinary Research, 1915, 215-280.

2, Trifur gailluarum spec. nov. From Latin gallina, hen.

Common name: Fowl-leucosis virus.

Host Gallus gallus (L.), chicken.

Geographical distribution. United
States, England, Europe.

Induced disease In chicken, neurolymphomatosis, with eye lesions (slate gray or blush color replacing normal bay color of iris), anemia, hemocytoblastosis, lymphoid, crythroid or mycloid types of leprosis; the hemocytoblastosis is followed by infiltration of the central neryous system, peripheral nerves, iris, and many visceral organs by hemocytoblasts and lymphocytes, producing lesions sometimes resembling neoplasms and consisting chiefly of hemocytoblasta (hemocytoblastomata); marrow of radius and ulna becomes hyperplastic; virus in blood plasma, blood cells, emulsions of organs; blood normal in its hydrogen-ion concentration; recovery never complete, some stocks less susceptible than others.

Transmission. By pen contact or contaminated litter. Experimentally by intravenous injection of cell-free filtrates. Not by the mesquitoes, Culex prints and Atdes acqupii (CULCIDAID. Dayold chicks from initis parents contain the infective agent and show some form of the induced disease in 80 per cent of the progeny if both parents show initis, in 70 per cent if male 1s normal, 15 per cent yf female is normal. Serological relationships: Specific neutralizing antibodies are formed in the rabbit as a result of injecting infective materials partly purified by sedimentation in the ultracentrituse.

Thermal inactivation. At 56° C in 30 minutes.

Filterability: Passes Berkefeld V, N, and W filter candles; 1.5 per cent, but not often 3 per cent, collodion membranes; Soitz asbestos filter.

Other properties: Viable after drying at least 5t days, in glycerine at least 10t days, at -60° Cat least 13t days, at -60° Cat least 6 months; after freeing and thawing, and after freeing in hundi air. Not viable after 14 days at 37.5° C. Particle diameter between 100 and 400 millimicrons.

Literature: Ellermann and Bang, Cent. f. Bakt., I Abt., Orig., 48, 1908, 4-5, 595-609, Furth, Proc. Soc. Exp. Biol, and Med., 27, 1929, 155-157; Jour, Exp. Med., 55, 1931, 243-267; 65, 1932, 465-478, 495-504; 58, 1933, 253-275; 69, 1931, 501-517; Furth and Miller, ibid., 55, 1932, 479-493; Hall et al., Am Jour. Vet. Res., 2, 1941. 272-270; Jármai, Arch. nissensch, u. prakt. Tierhielk., 62, 1930, 113-131; Johnson, Virginia Agr. Exp. Sta. Tech. Bull. 56, 1934, 1-32; Johnson and Bell. Jour. Inf Die., 58, 1930, 312-318; Kabat and Furth, Jour. Exp. Med., 71, 1910. 55-70; 74, 1941, 257-261, Lee and Wilcke, Am. Jour. Vet. Res., 2, 1911, 202-291; Lee et al , Jour Infect. Dis., 61, 1937. 1-20, Pierce, Am. Jour. Path., 18, 1912. 1127-1139, Ratcliffe and Stubbs, Jour. Inf. Dis., 80, 1935, 301-301.

No action on sugars.

Anaerobic, facultative.

Optimum temperature 20 to 25°C. Habitat: Sea water of Norwegian coast.

55. Pseudomonas calcis (Drew)

Kellerman and Smith. (Bacterium calcis Drew, Yearbook Carnegie Inst. Wash., 11, 1912, 136-144; Kellerman and Smith, Proc. Nat. Acad. Sci., 4, 1914, 400) From Latin calx (calc.), lime.

Ovoid rods, 1.1 by 1.5 to 3 microns, usually single but may form long chains. Actively motile with one polar flagellum. Gram-negative.

Grows best in sea water or 3 per cent salt media. Deposits CaCO<sub>1</sub>.

Agar colonies: Circular, with finely irregular outline, granular appearance, clevated, spreading; old colonies having brownish tinge in center.

Gelatin stab: Infundibuliform liquefaction.

Gelatin colonies Small, with liquefaction.

Broth: Good growth especially in presence of potassium nitrate, peptone or calcium malate.

Acid from glucose, mannite and sucrose but not from lactose.

Nitrates reduced to nitrites and ammonia.

Aerobic, facultative.

Optimum temperature 20 to 28°C. Habitat: Sea water and marine mud.

Bavendamm (Arch f. Mikrobiol., 5, 1903, 214) states that Pseudomonas calcis is probably synonymous with Bacterium brandti, Bacterium bauri and Bacterium feitelt described by Parlandt (Bull. Jard imp. Bot. St. Petersburg, 11, 1911, 97-105).

56. Pseudomonas calciprecipitaus Molisch. (Cent. f. Bakt., II Abt., 65, 1925, 190.) From Latin, calz (calc.), lime; praccipilo, to cast down headlong, to precipitate.

Thin rods: 0.5 to 0.8 by 1.5 to 3.6 mierons, with rounded ends, often staining irregularly. Motile, with one polar flagellum. Gram-negative.

Gelatin colonies: Circular, light brown in color (large colonies show CaCO; crystals).

Gelatin stab: Surface growth with filiform growth in depth. Liquefaction starts at bottom.

Agar colonies (sea water). Grayishwhite, glistening. In two to three weeks crystals of calcium carbonate form in the agar.

Agar slant: Slight, whitish, surface growth, becoming thick, spreading, glistening, with abundant CaCO<sub>3</sub> crystals in medium.

Ammonia formed.
Aerobic, facultative.

Optimum temperature 20°C. Habitat: Sea water.

57. Pseudomonas ichthyodermis (Wells Zobell) Zobell and Upham. (Achromobacter ichthyodermis Wells and Zobell, Proc. Nat. Acad. Sci., 20, 123, 1934; Zobell and Upham, Bull. Scripps Inst. Oceanography, δ, 1944, 246 and 253.) From Greek, ichthys, a fish; derma, ekin.

Small rods, 0.9 to 13 by 3 to 5 microns, occurring singly and in pairs. No spores. Encapsulated. Polar flagella. Pleomorphic forms predominate in old cultures. Gram-negative.

Requires sea water following initial isolation. The following differential me-

dia are prepared with sea water.

Agar colonies: Glistening, colorless, convex, circular colonies 2 to 4 mm. in

diameter.
Agar slants: Abundant, filiform, raised,

smooth, opalescent growth.

Gelatin tube: Rapid crateriform liquefaction complete in 5 days at 18°C. Sea water broth: Turbidity, with pelli-

cle, little granular sediment and no odor.
Milk: No growth. Casein digested
when 3 per cent salt is added.

Potato: No growth unless dialyzed in sea water. Then fair growth with no pigment. Literature: Bloch, Am. Jour. Path., 15, 1937, 939-944; Enders and Cohen, Proc. Soc. Exp. Biol. and Med., 50, 1942. Bol-154; Findlay and Clarke, Brit. Jour. Exp. Path., 15, 1933, 309-313; Johnson and Goodpasture, Jour. Exp. Med., 59, 1931, 1-19; Am. Jour. Hyg., 21, 1935, 46-57; 28, 1930, 329-339; Am. Jour. Path., 12, 1936, 495-510.

# 2. Rabula levis spec. nov. From Latin levis, trifling.

Common name Guinea-pig salivary-

Host. CAVIIDAE—Carra porcellus (L.), gunea pig (only known host; fetus more susceptible than post-natal animal, even if from immune mother).

Insusceptible species Rabbit, rat, ent, chicken, pigeon, dog, mouse, monkey (Macocus thems)

Geographical distribution : Un States, England.

Induced disease in guinea pig, submaxiliary glands show swollen epithelial cells containing relatively dense acidophilic inclusions of granular material withmenlarged nuclei, especially in ducts of the serous portion of the gland, and larger but fewer intracytoplasmic inclusuns, experimentally, by intracerebral injection of young guinea pig, prodromal period of about 2 days, then elevation of temperature to 105 or 106° F, a day later. hair raised, animal quiet , sulrequently, stratability with tremors and slight con vulsuse movements, by fifth day, usually prostration, jerking movements, and en sung death, brain shows no gross fesions but exadite over surface, in meningest exudate, many cells each containing an acadophilic mass within its nucleus, by subcutamous injection, sirus recuterable after 2 neeks from submaxillary glands. reryical lymph nodes, kidney, and lung. not from bleed, laser, or spicen

Transmission Experimentally, by in oculation of submanilary gland or by intracerebral or subrutaneous injection of materials from infected glands, with

difficulty from brain to brain. Pilocarpine stimulation increases numbers of inclusions.

Serological relationships 'Specific neutralizing antibody is found in blood serum of animals that are carrying virus in their submavillary glands.

Immunological relationships: Active immunity may be dependent on existence of more or less active lessons.

Thermal inactivation. At 51° C in 1 hour,

Filterability Passes Berkefeld N filter candle.

Other properties: Viable in 50 per cent elverine at least 11 days

Strans An unusually virulent strain, killing infected animals whatever the route of injection, has been described but not given a distinctive name (Rosenbusch and Lucas, Am. Jour. Path., 15, 1939, 303-340).

Literature, Andrewee, Brit, Jour, Exp. Path. II, 1930, 23-31, Cole and Kuttner, Jour, Exp. Med. J.41, 1926, 835-873, Hudson and Markham, third., 65, 1972, 405-415; Jackson, Jour, Inf. Das. 29, 1920, 317-359, Kuttner, Jour Exp. Med., J.61, 3927, 935-935, Kuttner and Tung, thid., 62, 1935, 805-822; Lucas, Am. Jour Path., I., 1936, 933-98, Markham, third., Id., 193, 311-322, Markham and Hudson, blid. J.f. 1936, 175-192, Pearson, third., 6, 1930, 201-274, Scott, Jour Exp. Med., J. 1920, 292-295, Scott and Fruett, Am. Jour. Path., 6, 1939, 537 6, 1930, Fath.

# 3 Rabula innocuus spre nos From

Latin innocuus, turmiess Common name Hamster salivarycland virus

Host CRICETIDAL Creciulus gri-

Insuscriptible species MURIDAE...

mt, the musculus L, white mouse Geographical distribution. China

Induced discuss. In humster, no obvious discuss externally but inclusion testors in submarillary glands. Thermal inactivation: At 56° C in 30 minutes.

Literature: Kuttner and Wang, Jcur. Exp. Med., 60, 1934, 773-791.

4. Rabula exiguus spec. nov. From Latin exiguus, petty.

Common name: Rat salivary-gland virus.

Host: MURIDAE-rat.

Insusceptible species: MURIDAE— Mus musculus L., mouse. CRICETI-DAE—Cricetulus griseus M. Edw., Chinese hamster.

Geographical distribution: China, Canada.

Induced disease: In rat, no obvious disease externally, but intranuclear inclusions in cells of the submaxillary glands.

Literature Kuttner and Wang, Jour. Exp. Med., 60, 1934, 773-791; Thompson, Jour. Inf. Dis., 60, 1932, 162-170.

5. Rabula latens spec. nov. From Latin latens, hidden or lurking.

Common name: Mouse salivary-gland virus.

Host: MURIDAE-Mus musculus L.,

Insusceptible species: MURIDAE rat. CRICETIDAE—Cricetulus griseus M. Edw., Chinese hamster. LEPOR-IDAE—rabbit. CAVIIDAE—Cavis porcellus (L.), guinea pig.

Geographical distribution: China, Canada, United States. Induced disease: In mouse, no obvious

Induced disease: In mouse, no obvious disease externally, but inclusion bodies in acinar tissue of scrous and mucous portions of submavillary glands; occasionally also in duct cells or alveolar cells of parotic gland; affected cells hypertrophied. In Swiss white mice, extensive lesions in liver and spiece but emulsions of these organs fail to infect; rare pancreatic lesions.

Transmission: Experimentally, by intraglandular, subcutaneous, intraperitoneal, intratesticular or intracerebral inoculation; inclusion bodies appear in salivary glands irrespective of site of inoculation.

Thermal inactivation: At 60° C in 30

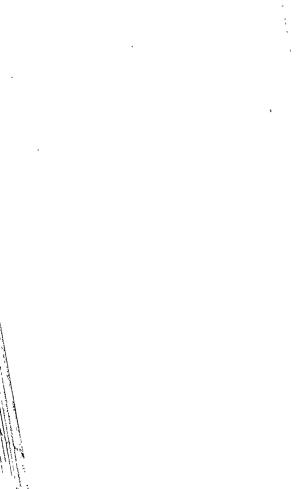
Filterability: Passes Berkefeld V filter

candle.
Literature: Kuttner and Wang, Jour.
Exp. Med., 60, 1934, 773-791; McCordock
and Smith, 1bid., 63, 1936, 303-310;
Thompson, Jour. Inf. Dis., 58, 1936, 69-63

## SUPPLEMENT NO. 3

# PLEUROPNEUMONIA AND PLEUROPNEUMONIA-LIKE ORGANISMS (BORRELOMYCETACEAE)

Louis Dienes Boston, Mars. May, 1945



## THE ORGANISM OF CONTAGIOUS BOVINE PLEURO-PNEUMONIA AND RELATED ORGANISMS\*

#### INTRODUCTION

The organism of bovine pleuropacumonia is similar in certain respects to filterable viruses. Both in infected tissue and in cultures, small elements are present which pass through filters that retain bacteria. The organism is not stained well by the usual bacterial stains and can be made visible only by using special methods. Bovine pleuropneumonia and other diseases caused by similar organisms were originally attributed to filterable viruses. These organisms are different from viruses in an important point; namely, they grow on suitable media in the absence of living host cells. The cultures consist of pleomorphic elements, the nature of which has only slowly become apparent. By the studies of Nowak (Ann. Inst. Past., 48, 1929. 1330), Turner (Jour. Path, and Bact. 41, 1935, 1) and Kliencherger and Smiles (Jour. Hyg., 42, 1942, 110), it has been established that the pleomorphic forms are part of a reproductive cycle different from binary fission. The small elements in the cultures swell up into large round forms which reproduce the small elements within their membranes. The morphology of the organism is further complicated by the fact that long branching filaments are present in freshly isolated bovine strains. These break un into granules or parts of the filaments swell up into large round forms. In the judgment of some investigators, these properties, in addition to unusual softness and fragility, exclude the organism of bovine pleuropneumonia and similar organisms from the order of true bacteria Ledingham (Jour. Path, and Bact . 37, 1933, 393) has classified them with the Actinomyces. Later, Turner (Jour. Path and Bact , 41, 1935, 1) placed them in an independent order, Barrelomucetales, while Sabin (Bact Rev., 5, 1941. 58) has even placed them in an independent class, Paramycetes,

The observations of the present author give support to the classification of Buchanan (Jour Bact, 3, 1918, 41) who placed the genus Asterococcus mycoides Borrel et al. with the organism of bovine pleuropneumonna (Asterococcus mycoides Borrel et al.) as type, together with the genus Haemophilus Winslaw et al. in subtribe Haemophilusa Buchanan of the tribe Bacteriaer Trevisan emend Buchanan. In many strains of the pleuropneumonia

Common names have been used through Supplement No. 3 incrept for Astrocessard, I. myrendra as the author behaves that a more suitable commendature of an any thus far proposed should be developed who marrie ment is reached as to the nature of these organisms. Specific names that have been proposed are given no relic as a matter of record. No new names have be a naturalized.

group, the small forms appear in appropriate preparations as small bipolar stained bacilli. The transformation of the bacilli to round bodies of variable size often occurs in bacterial cultures and is not specific for the pleuropneumonia group. Furthermore, it has been observed in several species of bacteria that they reproduce in the large round forms in a manner similar to that observed in the pleuropneumonia group. Thus the form variation and reproductive processes observed in the pleuropneumonia group are not specific to this group. They represent general bacterial properties and should be included in the definition of the true bacteria

According to these considerations, the organisms belonging to the pleuropneumonia group are small, Gram-negative bacilli often showing bipolar staining and their distinctive characteristic is the tendency to swell up into round forms and multiply by the reproduction of bacilli in the round forms. Their habitat is in the mucous membranes of animals and man and many of them are pathogenic. They are exacting in their media requirements and usually require fresh animal serum for their growth. These properties indicate a close similarity to the species now included in the genera Pasteurella and Haemophilus. The pleuropneumonia group might well be classified in the same or a closely related family. It is uncertain whether the strains isolated from earth and sewage should be classified with the strains isolated from animals and men. The soil and sewage strains are less soft, stain more easily and grow abundantly without animal serum. The strains isolated from bacterial cultures are most probably variant forms of the bacteria and should be classified with the parent organisms.

The viruses of psittacosis and lymphogranuloma present similarities to the pleuropneumonia group both in morphology and in their methods of reproduction. This gives added weight to the thought that the pleuropneumonia group represents an intermediary stage in the evolution of the small, Gram-negative bacteria of the mucous membranes into the filterable

viruses.

#### 1. THE PLEUROPNEUMONIA GROUP

(Borrelomycelaceae Turner, Jour. Path. and Bact., 41, 1935, 25; Parasifaceae Sabin, Bact. Rev., 5, 1941, 58.)

The organisms are soft and fragile. Without special precautions they are often distorted or entirely destroyed in microscopical preparations. The cultures contain pleomorphic elements. Small granules, bacilli, bacillary filaments and round forms varying in size from a few tenths of a micron to 10 microns or more Autolyzed round forms may coalesce into large empty blebs. The round forms are part of a reproductive cycle. They are produced by the swelling of the baculary forms and filaments and reproduce granules or filaments by inside segmentation or multiple germination. In freshly isolated boying strains, the filaments show apparent or true branching and reproduce the small forms by segmentation. The smallest growing units may not be fareer than 15 to 28 micron and pass through filters that retain bacteria. On agar. tiny colonies (0 1 to 0 6 mm) develop in great numbers The colonies invade the near and after 2 to 5 days growth have an oraque center embedded in the agar and a thin peripheral zone. The surface has a rugged of granular appearance due to the develorment and autolysis of the large forms. After a few days growth, the cultures usualy show pronounced autolysis. The parasitic strains require fresh animal seems for growth There is a single genus

## Genus I Asterococcus Borrel et al

(Borrel, Dujardin-Beaumetz, Jeantet and Jouan, Ann. Inst. Past., 24, 1910, 179; Coccodarillus Martinovski, Ann. Inst. Past., 25, 1911, 91; Micromyces Prosch, Arch. fo nissensch. up prikt. Therbeik, 49, 1923, 35 and 273, not Micromyces Dangeard, Le Botaniste, 1, 1888, 55, Mycoplasmo Nowak, Ann. Inst. Past., 45, 1929, 1349; Astronyces Wroblenski, Ann. Inst. Past., 47, 1931, 103; Borrelomyces Turner, Jour. Path. and Bact. 47, 1931, 1933, 25, Borrelomyces Eduhn, Bact. Rev., 6, 1941, 57, 1941, 57

Characters as for the family

The type species is Asterococcus mycoides Borrel et al

1. Asterococcus mycoides Borrel et al (Le mierobe de la périppeumonia, Nocard and Roux, Ann Inst Past . 12, 1898, 210. Borrel, Dujardin Beaumetz, Jeantet and Jouan, Ann Inst Past . 24, 1910, 168. Coccobacillus mucasdes nerspaeumoniae Martinovski, Ann Inst Past . 25, 1911. 914, Vieromyces perspacumoniae boris contamorae Frosch, Arch f wissensch u prokt Tierheilk . 49, 1921, 35 and 273 . Myroplasma perspacurioniae Noval. Ann Inst Past , 43, 1929, 1530 , Asiero muces perspacumoniae borns Wroblewski. 1nn Inst Past , 47, 1931, 94, Borrelemyers persparamoniae Turner, Jour Path Bart , 41, 1935, 1 , Borimpees pleu ropneumoniae Sabin, Baet Rev . 5. 1941. 57 1

Marphalogy of cells and appearance of

agar cultures correspond with the descrip-

Broth cultures are slightly opulescent and, upon shaking, the cultures of fresh strains exhibit silk like whorls, due to the presence of long chains and filtiments. The cultures after prolonged inculation consist of small granules.

Biochemical activity. Old colonies on serum agar develop a brownish color. Freshly isolated strains reduce hemoglobin. Glucove, fructiove, mannove, maltowe, and deating are fermented with the production of and but no gas. The cultures are bit available.

The etrains isolated from eattle are homogeneous in serological reactions and distinct from the other members of the group Habitat: It is the causative agent of contagious bovine pleuropneumonia. The disease can be transferred to sheep, goats and water buffaloes, but not to mice, rats, rabbits or other experimental animals.

2 The organism of agalactia of sheep and goats. (Le microbe d'agalacte contagieuse, Bridré and Donatien, Ann. Inst. Past., 39, 1925, 925; Anulomyces agalactae Wroblewski, Ann. Inst. Past., 47, 1931, 111; Borrelomyces agalactic Turner, Jour Path. and Bact., 41, 1935, 25. Capromyces agalactice Sabin, Bact Rev., 5, 1941, 57.)

These organisms are very similar to the former organisms in morphology, appearance of the cultures and growth requirements. Usually the growth is less vigorous, the colonies remain smaller, and the elements of the cultures are more delicate and less easily visible than those of bovine pleuropneumonia. Characteristic crystals develop in the cultures.

Serologically and immunologically this species is distinct from the bovine species.

It is the cause of a systemic disease in sheep and goats with involvement of the joints, eyes, and, in laciating animals, the mammary glands—Other species are not susceptible

3 Pleuropneumonia-like organisms in dogs. (Asterococcus cams, Types I and II, Schoentensack, Kitasato Arch. Exp. Med., 11, 1904, 227; 13, 1936, 175; Canomyces pulmons I and II, Sabin, Bact Rev., 5, 1941, 57)

Both types produce slight uniform opalescence in broth. Type I grows in granules and coarse colonies and is apparently pathogenic for dogs. Type II grows in somewhat larger granular colonies.

They are serologically distinct from each other and from the other members of the pleuropneumonia group The connection of these organisms with distemper is not proven.

- Pfeuropneumonia-like organisms in rats. L. (Klieneberger and Steabben, Jour. Hyg., 37, 1937, 143; Jour. Hyg., 20, 1940, 223; Murimyces pulmons Sabin, Bact. Rev., 5, 1941, 57.)
- L. (Klieneberger, Jour. Hyg., 58, 1938, 458; Murimyces arthritidis Sabin, loc cit.)

The pyogenie virus of Woglom and Varren (Jour. Exp. Med., 68, 1038, 513) and Lr of Findlay, MacKenzie, MacCallum and Rieineberger (Lancet, 287, 1939, 7) are identical with E. The organisms isolated from infected joint by Beeuwkes and Collier (Jour. Inf. Dis., 70, 1912, 1) and Preston (ibrd., 70, 1912, 150) probably are identical with L, but they were not typed seriosically.

The requirements for growth, the appearance of colonies and the morphology are very similar to those of the type strain with the difference that long filsments are not observed either in liquid or solid media.

The strains isolated from rats belong to two serological types. L<sub>I</sub> was cultivated from chronic lung abscesses, but the number of strains typed is not sufficient to ascertain that all strains isolated from this source belong to one type. The L<sub>2</sub> strains are not pathogenic for rats in artificial infection. They produce suppuration in mice when they are injected with agar.

L<sub>4</sub> which is scrologically different from L<sub>5</sub> was cultivated from abscesses and spontaneous polyarthritis It produces polyarthritis both in mice and rata. It is not infectious in monkey, rabbits and guinea pigs. Both L<sub>4</sub> and L<sub>4</sub> were recovcred from the brains of mice kept in the same room with rats.

According to Klieneberger, L, usually produces somewhat larger and coarser colonies than L<sub>1</sub>, L<sub>2</sub> grows in broth in small granules, while L<sub>4</sub> produces an opalescent growth.

5 Pleuropneumonis-like organisms in mice. (Sabin, Science, 88, 1938, 575, and Bact. Rev., 5, 1941, 1; Findlay, Kileneberger, MacCallum and MacKenzie, Lanect, 251, 1933, 1511.) A stran isolated by Sullivan and Dienes (Proc. Soc. Exp. Biol. and Med., 44, 1939, 620) is identical with Type A.

Five groups of strains, distinct semlogically, and, to a certain extent, distinct also in their pathological properties, have been isolated from mice. These are types A, B, C, D, and E of Sabin. The strains are clovely similar to each other and to the rat strains. It is questionable whether the slight differences in the appearance of the colomes and in the morphology of the cultures are of significance

Type A (Museulomyces neurolyticus Sabin) is usually present in the conjunctiva and was isolated also from the lung and brain. Intercerebral injection of Type A produces a mine a characteristic rolling disease due to a toxin which is also present in broth cultures. Intravenous injection produces a transient polyarthritis without datusace to the cartilage or ankylous. Type A is serologically similar to Lof Kheneberger, (Jour Hyg., 40, 1940, 2011).

Type B (Musculomyces arthrotropicus Sabini was isolated from the brain and from the raxal nuccos. If produces no rolling disease and no soluble toxin. In nuce, intravenous injection usually produces a chronic arthritis often leading to ankylous.

Types C. D and E. (Musculomyers his lottenguas Solum) were isolated from the same location as Type B and produce similar arthritic lessons. They are serologically distinct from Type B and from each other (Salum, Science, 20, 1979, 18 and Salum and Johnson, Proc. Soc. Lyp. Bool and Med. 44, 1910, 5290.

La sedated from mice by Findlay et al (Trans. Roy. Sec. Trop. Med. Hyg., 32, 1979-40, 6) and the strains of Edward (Jour. Path and Bact., 59, 1910, 409) were not compared serologically with the types of Sabin.

6 Pieuropneumonia-like organisms in man. (Dienes, Proc Soc Evp Biol. and Mad , 44, 1940, 468, Beveridge, Med Jour of Australia, 50, 1943, 479, Kleineberger, Lancet, 2, 1945, 46)

They are present in about 30 per cent of women in the gentials and they were isolated from suppurstive processes origmating from this source. In men they were found in urethritis, cystitis and chrome prostatitis.

The appearance of the colony, the morphology and growth requirements correspond with the animal strains Towless abundantly in scrum broth than the animal strains

One strain was found by Sabin (Proc. Sec. Pxp. Biol. and Med. 44, 1996, 560) to be serologically different from the strains volated from rate and mice. It is not known whether the strains are serologically uniform. There is a slight variation in colony form, in the tendency to grow in filaments, and in the abundance of growth, but the variation between the strains is less than the variation due to slightly different cultural conditions.

Mice and rats are usually not susceptible to infection with the human strains, however, several young mice from a single litter were killed in three to six days by subcutaneous or intraperituneal injection of one strain

7 Pleuropneumonia-like organisms in chick embryos. (Van Herrek and Exton, Jour Bact, 60, 1945, 47)

Organisms have been redated from chick embryos which conform to the pleatopneumona group with regard to morphology the appearance of colonies on agar and filterability. The cultures agalatinated red I lead cells from various annuals. The relation of this strain to the roccolonillary landers of Nelson (see Section II has not been studied.

# II. ORGANISMS OF UNCERTAIN CLASSIFICATION.

Similar to the Pleuropneumonia Group.

 Coccobacillary bodies of Nelson, (Nelson, Science, 83, 1935, 43; Jour. Exp. Med., 65, 1937, 833; Jour. Exp. Med., 78, 1940, 615.)

Nelson isolated a small bacillary organism apparently connected with coryza and infectious catarrh from the nasal passages of fowls and from the nasal passages and the middle car of mice and rats. Their size appeared to be 0.3 to 0.4 micron in microscopical preparations and they passed through a filter with a pore size of 640 millimicrons They were isolated in tissue cultures but they grow also in the cell-free and heated supernatant The freshly isolated cultures did not grow on blood or on artificial media: however, after 120 passages in tissue cultures the fowl coryza bodies grew on blood agar slants. On ascitic agar this strain forms colonies very similar to those of the pleuropneumonia group with a dark center surrounded by a thin periphery. The organisms in the top layer are sometimes considerably enlarged, but no web-like structure is produced. The organism is less soft and the individual organisms maintained their form in the preparations as do bacteria, and the tendency to grow into the agar is less pronounced than in the pleuropneumonia group. The organism isolated from rats is more pleomorphic than the others.

The coccobneillary bodies were not studied with methods appropriate to determine whether they belong to the pleuropneumona group and whether the mouse and rat strains are identical with the pleuropneumonia-like organisms isolated from mice and rats.

2. Filterable organisms from sewage and soil. (Fam. Saprophytaceae Sabin, Genus Sapromyces Sabin, Bact. Rev., 5, 1941, 59.)

The strains isolated by Laidlaw and Elford (Proc. Roy. Soc. London, B, 120, 1936, 292; Sapromyces laidlawi AB and C. Sabin, loc. cit.) and Seiffert (Cent. f. Bakt., I Abt., Orig., 189, 1937, 337) according to Orskov (Cent. f. Bakt., I Abt., Orig., 141, 1938, 230) and Klieneberger (Jour. Hyg., 40, 1940, 204) are closely similar to the organisms of the pleuropneumonia group They are filterable, and the smallest reproductive units of those which we have appropriately examined were found to be between .125 and .175 micron. The colonies are similar in appearance to the colonies of the pleuropneumonia group.

The both cultures consist of granules and round globular elements; the surface layer of agar colonies sometimes swells up into large round forms. They grow without serum, but small amounts of serum accelerate the growth. They grow both at 30° and at 37°C, and remain alive in cultures kept cold for several months. The broth cultures grow abundantly with a strong opalescence of sediment. Serologically the strains are distinct from the other members of the pleuropneumonia group and all but one are more or less similar to each other.

## III. PLEUROPNEUMONIA-LIKE ORGANISMS ISOLATED FROM BACTERIAL CULTURES.

1. Pleuropneumonta-like organisms isolated from Streptobacillus moniliformis. Li (Klieneberger, Jour. Path and Baet., 40, 1939, 93; Jour Hyrs., 48, 1942, 485; Dienes, Jour. Inf. Dis., 66, 1939, 21; Jour. Bact., 44, 1942, 37; Musculomyces streptobacilli-moniliformis Sabin, Bact. Rev., 5, 1911, 67; Heilman, Jour. Inf Dis., 69, 1911, 32; Brown and Nunemaker, Bull. Johns Hopkins Hosp, 70, 1942, 201)

Cultures isolated from different strains

Acid from glucose, maltose, sucrose and mannitol but not from lactose or glycerol.

Starch hydrolyzed.

Ammonia liberated from peptone but no hydrogen sulfide produced

Indole formed in tryptophane sea water broth.

Natrites produced from natrates

Optimum temperature 20 to 25°C, 30°C incubation will kill recently isolated organisms.

Aerobic, facultative

Source: Isolated from diseased kilifish (Fundulus partipinnis)

Habitat: Skin lesions and muscle tissue of infected marine fish.

53. Pseudomonas nigrifacieus White (Scientific Agriculture, 20, 1910, 643) From Latin ruger, black and faciens, making

Rods: 03 to 07 by 1 to 5 microns, occuring singly or in pairs, and having rounded ends. Actively motile, with a single polar flagellum Gram-negative

Celatin stab Pigmented surface grouth

faction changing to sacrate
Ager colonies. Circular,

smooth, glistening, entire, 2 to 4 mm in dameter. Slight fluorescence in early stage. The medium assumes a brownish color.

Agar slant Growth fillform, smooth, wout glustening, with blackish pigmentational 4° and 15°C in 48 hrs., the medium turing brownish Shight fluorescence in

early stages

Broth Turbid after 24 hours. After 5 to 6 days a black ring and then a pellicle forms, later a black sediment. Medium turns brown

Litaus milk A black ring appears after 3 days at 15°C followed by a pellicite. Litaus us reduced Aikaline reaction. No tegulation. Digested with a putrid oder.

ladele not formed.

Nitrites not produced from nitrates in 7 days. No gas produced.

Starch is hydrolyzed Natural fats not hydrolyzed. Alkaline reaction produced in sucrose.

maltose, lactose, glucose, manuitol and raffinose broth (pH 8.2). No gas produced

Ammonia produced in peptone broth.

Optimum pH 6.8 to 8.4.

Temperature relations: Minimum 4°C, Optimum 25°C. Maximum 33-35°C

Distinctive characters: No or slow growth in culture media in the absence of salt. Maximum growth and pigmentation appeared with 1.5 and 2.5 per cent salt. Optimum pigmentation occurs at 25 and 15°C.

Source: Several cultures isolated from samples of discolored butter.

Habitat Causes a black to reddishbrown discoloration of print butter. Evidently widely distributed in nature.

50 Pseudomonas beljerinckil Hof. (Travaux botaniques néerlandais, 52, 1935, 152.) Named for M. W. Beljerinck, Dutch hacteriologist.

Small rods: Motile with polar flagella. Gelatin: No liquefaction.

Indole not formed.

convex.

Nitrites produced from nitrates by

Cellulose not decomposed.

Acid from glucose. In yeast-water with 2 per cent glucose and 12 per cent NaCl no gas is produced.

Pigment production: Insoluble purple pigment produced but not in all media; is localized markedly; reduced oxygen tension necessary; optimum pil 80; not produced in yeast-nater or in persons mater; produced only when grown in extracts of beans or some other vegetable. Aerobic.

Source: Six strains isolated from beans preserved with salt.

Habitat: Causes purple discoloration of salted beans.

The strains, like the parent organism, are strictly anaerobic and the cultures have the characteristic odor of the parent strain.

It was observed in slide cultures that the L type of colonies develop from large round forms which were produced in the cultures of the parent organism by gradual swelling of the bacteria.

In cultures of eight pleomorphic strains of Bacteroides, the L type of colonies developed in three strains under appropriate conditions. The bacteria swelled into large round bodies in all eight strains. The serological properties of the L strains have not thus far been studied. Neither the parent organisms nor the L type strains had any pathological effect on laboratory animals.

3. Pleuropneumonia-like organisms in a species of Flavobacterium. (Dienes, Jour. Bact., 44, 1942, 37.)

Tiny colonies entirely similar in appearance to young L<sub>1</sub> colonies were isolated from the cultures of a species of Flavobacterium.

The bacterium when freshly isolated produced two types of colonies on blood agar plate; large colonies consisting of small regular bacilli and tiny colonies in which the bacteria became pleomorphic and swelled up to form large round bodies. The tiny colonies after 48 hourse of incubation became autolyzed, and one or several L type of colonies started to grow under them. These colonies could be transplanted and gave abundant growth for two generations, but always died out in the third.

Bacterial forms were not reproduced either on agar or in broth.

The L type of growth was not pathogenic for mice though the parent organism was highly virulent.

 Development of tiny colonies in other bacteria.

The development of tiny colonies similar in appearance to young colonies of the pleuropneumonia group has been observed in cultures of Escherichia oth, Haemophilus influenzae, and Neisteriae gonorrhoea (Dienes, Jour. Bett. 41, 1942, 37; Proc. Soc. Exp. Biol. and Med. 44, 1940, 476). In all cases preceding their development, the organisms of the parent strains swelled into large round bodies, and in Escherichia coti and Haemophilus influenzae the development of the Lyge of colonies from these large forms was observed. Thus far these tiny colonies have not been isolated in pure cultures.

of Streptobacillus moniliformis vary considerably in the appearance of the colonies, the tendency to reversion to bacillary form, and the degree of autolyeis. The colonies are considerably larger than the colonies of the human or animal oleuroppeumonia-like strains; they may reach 1 to 2 mm. Usualiv a wide peripheral zone is present and development and autolysis of the large bodies produces a course appearance in the colonies Sometimes no peripheral zone develops, the colony is dome-shaped, and the large bodies have no tendency to autolyze. The young colonies (twelve hours incubation) grow into the agar as loose strands of more or less swollen granules. Serum broth cultures grow in small clumps usually adhering to the wall of the test tube

The cultures consist of small granules. small polar-staming bacilli and diphtheroid like forms which swell to large round forms. In the top layer of fully developed colonies, the well-stained large bodies may be as large as 10 to 20 microns By vacuolization they transform into empty blebs. By segmentation of their contents, the large forms may reproduce the small breillary forms. In suitable preparations chromatin bodies are visible both in the small and large forms. The small forms are filterable through Berkfeld candles, the size of the smallest terricles has not been exactly determined. The organism is very soft and freede

Their growth requirements and bus chemical activities are similar to those of Streptobacellus monthforms

Growth occurs on nutrient sear connium gammal writin or erg yolk. Some times there is a slight growth on boiled blood sear plates without serum. Good growth is obtained in a mineral solution with 01 per cent starch. Growth is both service and sweeping.

The La form is more resistant to heat and to aging of the culture than is the attributed line and it has a remarkable resistance to pentrillin to which the inc-

teria are very sensitive. Like the bacillus, L<sub>1</sub> produces acid but no gas from glucose, maltose, fructose, salicin, starch, and destrin. It gives no oxidase test.

Serologically the L<sub>I</sub> form is similar to Streptobacillus monutiformits and different from the members of the pleuropneumona group. It has no pathological effect on muce, rats or guine pigs. It does not produce an infection of the chicken embryo. It can be isolated from freshly isolated strains of Streptobacillus monutiforms, from several-day old broth and agar cultures, from both cultures heated at 56°C. and usually also from 48 hour agar cultures if they are incubated at 23° to 30°C. It is questionable whether the L<sub>I</sub> form has been isolated directly from rats.

Klieneberger (Jour. Hyg., 40, 1910, 201)
solated a similar strain from a bacterium
similar to Streptobacillus menulyformis
which caused abscesses in guinea pigs.
Whether this bacterium was identical or
different from Streptobacillus monitiforms was not determined.

2 Pleuropueumonia-like organisms isolated from Bacteroldes fundulformis. Duenes (Proc Soc Esp. Buol. and Med., 47, 1911, 383) and Dienes and Emith (dour Bact, 48, 1911, 123) isolated cultures from two strains of Bacteroides fundulformis which could be propagated in the appearance of colonies were closely similar to it.

The young colonies consisted of similar attrails of granules growing into the medium. The surface of fully developed colonies consisted of large bodies and a boney combines structure. The will colated colonies grew usually to a fairly large size (i to 2 mm).

Hoth strains, transplanted every two or three days through several months, failed to reproduce the control of the

tures.

Amphibia (continued)	Animal Products (Vertebrate)
Toads	Catgut for sutures
Arthromitis, 1903	Bacillus, 815
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Micrococcus, 281	Colony on old plate
Serratia, 462	Micrococcus, 281
· Vibrio, 197	Containing iodoform
, abscesses	Micrococcus, 272
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-, intestine	Bacillus, 756
Spirochaeta, 1066	Glue
-, large intestine	Black discoloration
Spirillum, 217	Chromobacterium, 233
Treponema, 1075	Hides, salted
-, rectum	Pseudomonas, 110
Bacterium, 760	Sarcina, 289
-, tadpoles	
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rasicarena, ono, or :	•

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<sup>\*</sup>Proposed by Prof. Robert S. Breed and Mrs. Margaret L. Breed, Geneva, New York, August, 1947.

f Propored by Frances O Holmes, Rockefeller Institute for Medical Research, Princeton New Jersey, July, 1917.

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60. Pseudomonas salinaria Harrison and Kennedy. (Harrison and Kennedy, Trans. Royal Soc. of Canada, 16, 1922, 121; Serratia salinaria Bergey et al., Manual, 1st ed., 1923, 93; Flavobacterium (Halobacterium) salinarium Elazari-Volcani, Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ, Jerusalem, 1940, 59) From Latin, salinae, saltworks.

Probable synonym: Serratia sambharianus Dixit and Vachna, Current Sci., 11, 1942, 107 (see Biol Abs., 17, 1943, 793). Halophilic growing in 30 per cent salt. From salt lake in India

Occurs as spheres and rods, 20 to 30 microns in diameter, 1.0 to 1.6 by 3.0 to 150 microns, occurring singly, as ovoid, amoeboid, clavate, cuneate, truncate, spindle, club, pear-shape, and irregular forms. Motile, frequently with a flagellum at each pole Gram-negative.

Does not grow on ordinary culture media. Grows well on salted fish.

Codfish agar (16 to 30 per cent salt): Growth slow, smooth, raised, coarsely granular, entire, pale pink to scarlet (Ridgway chart).

No acid from carbohydrate media. Indole not formed.

Nitrites not produced from nitrates.

Aerobic, facultative Optimum temperature 42°C.

Source: Isolated from cured codfish (Harrison and Kennedy, loc. cit ) Isolated from salted fish by Browne (Absts Bact., 6, 1922, 25 and Proc. Soc. Exper. Biol and Med., 19, 1922, 321) who regarded this pleomorphic bacterium as two organisms—Sprochaeta haloshilica

and Bacterium halophilica
Habitat: Produces reddening of dried
codfish and causes rusty herring. In
sea salt, and salt ponds containing not
less than 16 per cent salt

Pseudomonas cutirubra Lochhead.
 (Serratia cutirubra Lochhead, Can. Jour.

of Research, 10, 1934, 275; Bacterium cutirubrum Lochhead, Jour. Back., 27, 1931, 62; tbid., 45, 1943, 575; Flavobacterium (Halobacterium cutirubrum Elazari-Volcani, loc. cit., 59.) From Latin, cutis, skin, hide; ruber, red

Occurs as rods and spheres. Spheres 1 to 1.5 microns in diameter. Rods 1.5 to 80 by 0.7-1.4 microns. Rod forms motile with single polar flagellum. Coccoid forms motile when young. Gramnecative.

No growth on ordinary media.

Milk agar (20 per cent salt to saturation; optimum 23-32 per cent): Colonies 3-4 mm. in diameter, round and slightly convex. Pink to rose dorée (Ridgway chart).

Milk agar slants: Growth filiform, slightly spreading, rather flat with smooth, glistening surface and membranous consistency. Proteolytic action. Liound media: No or slight growth.

Gelatin (salt): Pronounced liquefaction.
Indole not formed, Lochhead (loc. cit.),
Faint test, Gibbons (Jour. Biol. Board

Canada, 3, 1936, 75).

Nitrites not produced from nitrates.

Diastatic action negative.

No carbohydrate fermentation.

Aerobic, obligate.

Optimum temperature 37°C. Halophilic.

Source. Isolated from salted hides. Habitat: Sea water and sea salt.

62. Pseudomonas harveyi Johnson comb. nov. (Achromobacter harveyi Johnson and Shunk, Jour. Bact., 31, 1936, 587.) Named for E N. Harvey; who studied luminous bacteria.

Rods · 0 5 to 1.0 by 1.2 to 2.5 microns, occurring singly or in pairs, with rounded ends Occasionally slightly curved; ends occasionally slightly pointed. Non-spore-forming. Capsules absent. Motile with a single polar flagellum, 2 to 3 times the length of the cell Gram-negative.

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Sea water gelatin colonies After 24 hours at 20°C, circular, about 15 mm in diameter or larger, margin slightly undulate, sunken due to the beginning of liquefaction, interior somewhat zonate, colonies surrounded by a halo of numerous small secondary colonies, circular and finely granular In crowded plates a large number of gas bubbles are formed Luminescent.

Sea water gelatin stab Rapid saccate inquefaction complete in 5 days at 22°C Abundant flocculent sediment

Sea water agar colonies: Mostly very large, 6 to 8 cm. in diameter in 24 hours, flat, highly iridescent, circular with undulate margin, or composed of narrow and close or wide filamentous growth Occasionally small colonies appear that are circular, with entire or slightly undulate margin, often producing irregular secondary growth, surface always smooth Luminescent.

Sea water agar slant Growth abundant, spreading, grayishly viscous, homogeneous, iridescent, the medium becoming rapidly alkaline when inoculated at an initial pH of 7.0 With fish decections added to the medium, luminescence is much brighter and growth becomes brownish after seweral days.

Growth on autoclaved fish Abundant, smooth, glistening, yellowish, becoming dirty brown after several days. Mild putrefactive odor. Luminescence very brilliant.

Sea water containing 0.2 per cent peptone: Abundant uniform turbuity, thin pelhele, sediment accumulating over a period of several days. Luminescence at surface only unless the tube is shaken Milk, with or without the addition of

28 per cent salt . No growth

Potato plugs resting on cotton saturated with sea water: Growth slight, somewhat spreading, slightly brownish. Luminous Indole is formed (Gore's method).

Nitrites are produced from nitrates.

Ammonia is produced in peptone media (Hansen method). Fived soid from glucose, fructose, mannose, galactose, sucrose, malose, mannitol, devtrin, glycogen, trehalose, cellobiose; slowly from salten Nonfixed acid from meletitose, slight acid from sothitol, disappearing in 24 hours. No acid from glycerol, ydose, arabinose, dulcitol, inositol, adonitol, erythritol, arabitol, lactose, rafinose, rhamnose, tucose or albola methyl clucoside.

Starch agar. Wide zone of hydrolysis
Hydrogen sulfide is produced (Zobell
and Fantham method).

Temperature relations Optimum 35° to 39°C Abundant growth at 22° to 25°C Optimum luminescence at 20° to 40°C.

Not pathogenic for white rats or amphipods.

Aerobie, facultative anaerobe

Source Isolated from a dead amphipod (Talorchestia sp.) at Woods Hole, Massachusetts

Habitat Sea nater.

63 Pseudomonas phosphorescens (Fischer) Bergey et al. (Bacilus phosphorescens Fischer, Zottechr I. Hyg., 2, 1887, 58, Photobacterium indexum Beijerinek, Arch Néerl d Sei Exactes, 23, 1889, 401; Bacterium phosphorescens Lehmann, Cent I Bakt, 5, 1889, 765; not Bacterium phosphorescens Fischer, Cent I Bakt, 3, 1888, 107, Bergey et al., Manual, 3rd ed., 1939, 1977) From Greek phosphorek, to bear or bring light.

See page 600 for additional synonyms Description taken from Fischer (loc. cit.)

Small, thick rods 2 to 3 times as long as wide, with rounded ends Motile. Stain lightly with aniline dyes

Gelatin colonies After 36 hours, small, circular, gray-white, punctiform. Liquefaction Bluish to green phosphorescence in 4 to 5 days.

Blood scrum: Gray-white, slimy growth.

Potato. Thin white layer in 2 to 3 days.

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Eubaclerium, 368	Klebsiella, 459
Gaffkya, 281	Influenza
Hiblerillus, 822	Streptococcus, 340
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Microcorcus, 261	Shigella, 512
Liver	Lymphangitis, ulcerative
Malleomyces, 555	Corynebactersum, 389
Salmonella, 507	Nasal secretion in glanders
Nasal passages	Bacterium, 683
Corynebacterium, 385	Pacumonia
Not pathogenic for Avian tuberculosis	Bacterium, 684
Mycobacterium, 880	Streptococcus, 339
Pneumonia	-, infectious of foals
Corynethrix, 407	Corynebacterium, 391
Respiratory tract	Purulent infections, urinary tract
Streptococcus, 318, 337	Corynebacterium, 389
Salara	Pus, respiratory tract
Nocardia, 975	Streptococcus, 318
Skin	Ringworm
Corynethrix, 406	Actinamuces, 916
Spleen	Stomatitis
Malleomyces, 555	Treponema, 1074
Throat	Strangles
Streptococcus, 315	Streptococcus, 318
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Sarcina, 201	Corynebacterium, 385
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Carrion's disease	Actinomyces, 916, 968, 969
Bartonella, 1101	Bacillus, 741
Catarra	Bacterium, 759
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Staphylococcus, 282	Mimeae, 595
-, acute	Neisseria, 301
Staphylococcus, 282	Streptothrix, 924
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Corynebacterium, 401	Moraxella, 591, 592
Central and South African relapsing	-, granular
fever	Bacillus, 589
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Cerebrospinal meningitis, epidemic	-, inclusion
Neisseria, 297, 302	Chlamydozoon, 1115
Chancroid	-, neonatal
Hemophilus, 587	Chlamydozoon, 1115
Chancroidal ulcers	-, swimming pool
Streptococcus, 341	Chlamydozoon, 1115
Chicken pox pustules	Cornea, infected
Streptococcus, 345	Bacterium, 679, 685
Choleocystitis	Corneal ulcerations
Ristella, 577	Morazella, 591, 592
Cholera	Cracked heels
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Vibrio, 198	Actinomyces, 918, 974
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Colitis	Dengue
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Anemia	Bacillus, 619, 728
Haemobartonella, 1104	Micrococcus, 253
-, pernicious	Black water fever
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Streptobacillus, 580	Pseudamonas, 89
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Anorestal inflammation	
Miyagawanella, 1116	Rickettsia, 1089, 1098
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Anthrax	Streptococcus, 338
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Micrococcus, 263	Capsularis, 577
Proteus, 691	Streptococcus, 332
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Ramsbactersum, 369	Bacillus, 613
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Balantis	Cancer of the stomach
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Banti's disease	Cancerous tiesue
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Exanthematous typhus

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Febrile illness

Rickellsia, 1008 Felons with red pus

Serratia, 484 Fever, see

Blackwater fever

Boutonneuse fever Bullis fever

Columbensis fever Endemic typhus

Enteric fever

Eruptive fever European typhus

Dutch East Indies fever

Five day fever Kenya typhus

Malta fever Marseilles fever

Mediterranean fever Mexican typhus

Mianeh fever (Persia)

Murine typhus Oroya fever Paratyphoid Parenteric fever

Parrot fever Postnatal fever Pretibial fever

Puerperal fever

Q (Queensland) fever Rat bite fever

Recurrent fever

Rocky Mountain spotted fever São Paulo exanthemic fever, Brazi

São Paulo exanthemic fever, Brazil Scarlet fever

Scrub typhus Seven day fever, Japan Shin bone fever

South African tick bite fever South American relapsing fever

Spanish relapsing fever Spanish relapsing fever Spotted fever, Minas Geraes Swamp fever, Europe

Tobia fever, Colombia

Trench fever Typhoid fever

Typhus fever Western relapsing fever

Walhynian fever Yellow fever

Five-day fever Rickettsia, 1005

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Gangrenous pulp, tooth

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Dental caries (continued)	Diplococcus, 307
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Leptotrickia, 365	Capsularis, 577
Streptococcus, 320, 339, 311, 312	Endemic typhus
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Influenza	Louisiana pneumonia
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Hemophilus, 585, 586	Lung diseases
Micrococcus, 264, 272, 277	Actinomyces, 970
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Streptococcus, 340, 341, 342, 314, 345	-, exudate
-, nasal washings	Sarcina, 290
Veillonella, 303	Lupus
Intestinal intoxication	. Bacillus, 661
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Intestinal ulcer	Miyagawanella, 1116
Bacterium, 677	Lymphogranuloma venereum
Jaundice, acholuric	Miyagawanella, 1116
Streptomyces, 958, 962, 963, 965	Madura foot
Spiroschaudinma, 1071	Nocardia, 909, 915
-, infectious	Streptothrix, 924
Leptospira, 1077	Malignant edema
Pseudomonas, 90	Bacillus, 826
Kenya typhus	Proleus, 691
Rickettsta, 1080	Malignant tumor
Keratitis	Spirochaeta, 1067
Actsnomyces, 915, 917	Malta fever
Discomyces, 918	Brucella, 561
Kolpohyperplasia eystica	Marseilles fever
Bacillus, 826	Rickettsia, 10S9
Leproma	Mastitis
Actinomyces, 916	Tetracoccus, 284
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Mycobacterium, 882, 887	Bacteroides, 566
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Mycobacterium, 882	Staphylococcus, 262
Leprous lesions	Measles
Mycobacterium, 882	Diplococcus, 311
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Bacterum, 689	Streptococcus, 341
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Lichen planus	Mediterranean fe
Ristella, 576	Rickettsia, 1080
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	Malleomyces, 556
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Lingua nigra	Bacillus, 882
Oospora, 922	Cillobacterium, 369
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Inver, acute yellow atrophy	Malleamuces, 556
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-, infected	Salmonella, 505, 522, 527
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Gas gangrune (con'inved)	Bacterium, 677
Closterdium, 773, 778, 782, 783, 781,	Pasteurella, 319
788, 791, 791, 796, 821	Hodgkin's disease, lymph glands
Martellillus, 523	Corpnebacterium, 402, 403, 404
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Garcous edema	Mayayawanella, 1119
Clostradium, 825	Indun relapsing fever
Gascous phlegmons	Barrelia, 1062
Bacillus, 826	Infant diarrhoes
Gastrie demagement	Streptoroccus, 339
Bacellus, 739, 814	Infantiliem
Gastro-nteritis	Bacellus, 746
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Paracoldactrum, 400	Actinompers, 973
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Leptospira, 1977	Streptompeer, 961, 962, 963, 961, 965, 967
Gingivitie	-, sem-, legs and chest
Furthertenum, 583	Actinomyces, 917
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Glat lets like disease	genitouritary tract
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Cooked fish: Abundant growth. Entire surface covered with a gray-white, slimy growth. Bluish-white phosphorescence.

Alkaline broth: Slight turbidity in 24 hours. Pellicle in 3 days.

Acid broth: No turbidity. No phosphorescence.

Milk: No growth.

No gas formed.

Not pathogenic for laboratory animals.

Aerobic.

Optimum temperature 20° to 30°C. Source: From sea water of the West Indies.

Habitat Sea water

64. Pseudomonas plerantonii (Zirpolo) Bergey et al. (Micrococcus pierantonii Zirpolo, Boll. del. Societa dei Natural. in Napoli, 51, 1918, 75; Cocco-bacillus pierantonii Meissner, Cent. f. Bakt., II Abt., 67, 1920, 201; Bergey et al., Manual, 3rd ed., 1930, 176) Named for Pierantoni, an Italian.

Oval rods: 0.8 by 1.0 to 20 microns. Polymorphic rods, sometimes vacuolated. Motile. Gram-negative.

Gelatin colonies: Circular, luminous. Gelatin stab. Not liquefied.

Sepia agar colonies Circular, white, convex, smooth, serrate edge. Intense greenish luminescence.

Egg-glycerol agar slant: Yellowishgreen, luminous streak.

Broth: Turbid.

Indole not formed.

Acid from glucose and maltose, some strains also produce acid from lactose and sucrose.

Best growth in alkaline media.

Aerobic.

Optimum temperature 33°C.

Source Isolated from the photogenic organ of the cephalopod Rondeletia minor. \*65. Pseudomonas martyniae (Elliott) Sapp. (Bacterium martyniae Elliott, Jour. Agr. Res., 29, 1924, 490; Stapp, in Sorauer, Handbuch der Pflanzenkr., 2, 5 Auf., 1928, 278; Phytomonas martyniae Bergey et al., Manual, 3rd ed., 1930, 262.)
From M. L. Martynia, a generic name.

Rods: 0.59 to 1.68 microns. Capsules. Chains. Motile with one to several bipolar flagella. Gram-negative.

Green fluorescent pigment produced. Gelatin: Liquefied.

Beef agar colonies: White, round, smooth, glistening, raised.

Broth: Clouding in bands. Thin pellicle. Small crystals.

Milk: Soft acid curd with peptonization.

Nitrites produced from nitrates after 2 weeks.

Indole not produced.

Hydrogen sulfide production slight.

Acid but not gas from glucose, galactose, arabinose and sucrose. No acid from rhamnose, lactose, maltose, raffinose, mannitol and glycerol.

Starch hydrolysis none or feeble.

Optimum temperature 26°C. Maximum 37°C. Minimum 1.5°C.
Optimum pH 6.0 to 6.7. pH range 5.4

Optimum pH 6.0 to 6.7. pH range 5.4 to 8.9.

Aerobic.

Source: Isolated from diseased leaves of the unicorn plant from Kansas.

Habitat: Pathogenic on Martynia louisiana.

66. Pseudomonas stitafaciens (Eliott) Burkholder. (Bacterium striafaciens Elliott, Jour. Agr. Res., 55, 1927, 823; Phytomonas striafaciens Bergey et al., Manual, 3rd ed., 1930, 203; Burkholder, Phytopath., 32, 1942, 601.) From L. stria, stripe; faciens, making,

<sup>\*</sup> The section covering the pseudomonads that cause plant diseases has been revised by Prof. Walter H. Burkholder, Cornell Univ., Ithaca, New York, April, 1943.

Human Diseases (continued)	Osteomyelitis
meningitis (continued)	Bacillus, 664
Streptoroccus, 311	Restella, 575
-, cerebroinaple fluid	Streptococcus, 230
Neisseeia, 29	Osteophlegmon, maxillary bone
-, purulent	Pseudomonas, 701
Bacterium, 676, 682	Otitis
Hemophilus, SS	Hacteroides, 567
Sphartophorus, 579, 580	Cillabacterium, 319
Meningopheumonitis	Sphaerocillus, 580
Meyagawanella, 1117	Sphaerophorus, 579
Mexican typhus	Otitis media
Richettera, 1085	Bacillus, 666
Mianch lever, Person	Carynebactersum, 402
Spirechaeta, 1000	Diplococcus, 307
Moddle car infections	Otens
Staphylacoccus, 252	Hacellus, 658
Mite bite lesions (eschar)	Corynebacterium, 407
Rickettina, 1001	Kleberella, 450
Monwean relations fever	Pseudemonas, 95
Spirartaria, 1967	Salmmella, 371
Multiple sclerosis	Sarcina, 272
Sperochaeta, 1065	Streptorocous, 340
Murine typhus	-, prestriant
Rickettiin, 1087	Microcorcus, 266
Viyretoma	Paraty phond
Actinomyces, 916, 914	Salmonella, 1911, 1817, 1899, 1882
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Strey tompers, 850, 661, 666	Micrococcus, 270
Suepludna, 724	Parrot fever
Maceus fungules	Meyoporanella, 1117
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Human Diseases (continued)	-, catarrhal
Peritoncal evudate	Baclerium, 687
Sphaerophorus, 579	-, louisiana
Peritonitis	Miyagau anella, 1119
Clostridium, 820	-, septic
Ramibacterium, 369	Bacterium, 684
<ul> <li>Streptococcus, 307</li> </ul>	, virus
Pernicious anemia	Miyagawanella, 1119
Salmonella, 522	Pneumonie plague
Pertussis	Pasteurella, 549
Bacterium, 590	Pneumonitis
Hemophilus, 586, 589	Miyagawanella, 1119
Petechiae in skin	Polyarthritis
Neisseria, 297	Corynebacterium, 402
Phagadenous ulcer	Postnatal fever
Borrelia, 1064	Corynebacterium, 405
Pharyngitis	Postpoliomyelitie paralysis
Zuberella, 578	Verlionella, 304
Phiegmon, perinephritic	Pretibial fever
Streptococcus, 329	Rickettsia, 1098
Phthisis	Prostatitis
Bacterium, 687	Actinomyces, 918, 974
Sareina, 293	Pseudoactinomycosis
Pink eye	Actinomyces, 916
Bacillus, 589	Nocardia, 921
Pinta	Pseudodysentery
Treponema, 1073	Shigella, 538
Pityrasis	Pseudomycosis
Discomyces, 919	Micrococcus, 696
Plague	Pseudotuberculosis, pulmonar
Pasteurella, 549	Nocardia, 919
Pleurisy	Psittacosis
Streptococcus, 329, 332	Rickettsia, 1095
-, purulent	Miyagarcanella, 1117
Eubacterium, 367	Psoriasis
Pasteurella, 554	
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Bacillus, 647, 665, 703, 918	Staphylococcus, 701
Brucella, 563	Pulmonary mycosis
Diplococcus, 307	Oospora, 923
Klebstella, 458	Pulmonary oosporosis
Salmonella, 518	Oospora, 922
Streptococcus, 341	Pulmonary tuberculosis
Pacumonia, atypical	Actinomyces, 917 Mycobacterium, 878, 897
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Pulmonary tuberculosis (continued)	Bacterium, 685
Oospora, 923	Sphaerophorus, 580
Streptococcus, 343	Pyorrhoea
Purulent pleural fluid	Streptothrix, 923
Salmonella, 577	Pyorrhoea alveolaris
Purulent urethral discharge	Micrococcus, 262
Spirochaeta, 1074	Spirochaeta, 1069
Pus	Treponema, 1072
Actinomyces, 916, 927, 971, 974	Veillonella, 303, 304
Bacillus, 659, 665, 737, 826	Pyrexia
Bacterium, 678, 685	Salmonella, 519
Clostredium, 806	Q (Queensland) fever
Corynebacterium, 403, 406	Coxiella, 1093
Leptospira, 1078	Rabies
Micrococcus, 241, 242, 243, 251, 256,	
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Nocardia, 921	
Oospora, 922	Proteus, 691
Proactinomyces, 923	Rat bite fever
Sarcina, 293	Actinomyces, 972, 974
Spirochaeta, 1069	Spirsllum, 215
Staphylococcus, 282	Streptothrix, 924
Streptococcus, 316, 321, 326, 341	Rectal ulcer
Streptomyces, 963	Eubactersum, 367
Pus, anal pocket	Recurrent fever
Corynebacterium, 406	Spirochaeta, 1067
—, blue	Red perspiration
Pseudomonas, 89	Micrococcus, 263
-, cars of scarlet fever patients	Relapsing fever
Corynebacterium, 402, 403	Borrelia, 1060, 1061, 1062, 1063, 1064
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referring to the type of lesion caused on the blades of oats.

Rods: 0 66 by 1.76 microns. Motile with one to several flagella. Capsules Gram-negative.

Green fluorescent pigment produced

Gelatin, Liquefied.

Becf-peptone agar colonies White, raised, margins entire or slightly undulating

Broth: Clouding in layers Ring and slight pellicle

Milk: Alkaline, sometimes a soft curd which digests or clears

Slight production of nitrates from nitrates.

Indole not produced

Acid but not gas from glucose, fructose and sucrose. No acid from lactose, maltose, glycerol and mannitol

Starch: Hydrolysis slight.

Optimum temperature 22°C Optimum pH 6.5 to 7.0

Acrobic.

Distinctive characters Differs from Pseudomonas coronafaciens in that the cells are somewhat smaller and the pathogen produces a streak on eat blades instead of a halo snot

Source · Forty cultures isolated from oats gathered in various parts of America

Habitat: Pathogenic on cultivated oats, and to a slight degree, on barley.

67. Pseudomonas tomato (Okabe) comb nov. (Bacterium tomato Okabe, Jour Soc Trop Agr Formosa, 6, 1933, 32, Phylomonas tomato Magrou, in Hauduroy et al., Diet. d Baet. Path., Paris, 1937,

422) Named for the host plant, tomato Probable synonym Bacterium punctulans Bryan, Phytopath., 23, 1933, 897

tulans Bryan, Phytopath., 23, 1933, 897 Rods: 0 69 to 0 97 by 1 8 to 6 8 microns Motile with 1 to 3 polar flagella Gram-

negative.
Green fluorescent pigment produced in culture.

Gelatin: Slow liquefaction.

Reef-extract agar colonies White, circular, flat and glistening.

Broth: Turbid in 21 hours Pelliele

Milk: Becomes alkaline and clears. Nitrites are usually produced from nitrates

utrates
Indole not produced

indote not broduce

No HaS produced.

Acid but not gas from glucose, sucrose and lactose No acid from maltose and glycerol.

Starch hydrolysis feeble.

Slight growth in 3 per cent salt

Optimum temperature 20° to 25°C. Maximum 33°C.

Aerobic,

Source Isolated from diseased tomato leaves

Habitat Pathogenic on tomato, Lycopersicon esculentum

68 Pseudomonas aceris (Ark) Burkholder (Phytomonas aceris Ark, Phytopath, 29, 1939, 969, Burkholder, Phytopath, 32, 1942, 601) From Latin acer, maple, M.L. Acer, generic name.

Rods 0.3 to 0.8 by 0.8 to 2.5 microns.

Mottle with 1 to 2 polar flagella. Gram-

necative

Green fluorescent pigment produced

Gelatin: Liquified

Beef-extract-peptone agar, Colonies are

grayish-white Appearing in 24 hours. Broth Turbid.

Milk Clearing with no coagulation Nitrites not produced from nitrates

Indole not produced from nitrate

Hydrogen sulfide not produced,

Acid from glucose, fructose, galactose, arabinose, xylose, sucrose, maltose, lactose, raffinose, mannitol, glycerol and dulcitol

Slight growth in broth plus 6 per cent salt (Burkholder)

Temperature, 13° to 31°C.

Source From diseased leaves of the large leaf maple, Acer macrophillum Habitat: Causes a disease of Acer spp

69 Pseudomonas angulata (Fromme and Mutray) Holland (Bacterium angulatum Fromme and Murray, Jour Agr. Res., 16, 1919, 219; Holland, Jour. Bact. 5, 1920, 221; Phytomonas angulata Pergey

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et al., Manual, 3rd ed., 1930, 267.) From L. angulatus, referring to the type of lesion produced on the tobacco leaf.

Description taken from Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 24).

Rods. 0.75 to 1.5 by 1.5 to 3 0 microns. Motile by 1 to 6 polar flagella Gramnegative

Gelatin · Liquefaction.

Green fluorescent pigment produced. Beef-extract agar colonies: Dull white,

circular, raised, smooth and glistening.

Broth: Turbid in 36 hours and greenish.

Milk Alkaline.

Nitrites not produced from nitrates.

Indole not produced.

No H<sub>2</sub>S produced. Lipolytic action negative (Starr and Burkholder, Phytopath., 32, 1942, 601).

Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xylose, sucrose and mannitol. Alkaline reaction from salts of citrie, malic, succinic and tartaric acid. Rhamnose, maltose, lactose, raffinose, glycerol, salicin, and acetic, lactic and formic acids are not fermented.

Starch not hydrolyzed.

Slight growth in broth plus 5 to 6 per cent salt (Burkholder).

Facultative anaerobe.

Distinctive characters: Braun (Phytopath, 27, 1937, 283) considers this species to identical in culture with *Pseudomonas tabaci*, but they differ in the type of disease they produce.

Sources: Isolated by Fromme and Murray from small angular leaf spots on tobaccors

at Causes the angular leaf spot

seudomonas aptata (Brown and on) Stevens. (Bacterium aptalum and Jamieson, Jour. Agr. Res. 1, 208; Phytomonas aptata Bergey et Ianual, 1st ed., 1923, 184; Stevens, v Disease Fungi, New York, 1925, 10 your Latin aptatus adapted.

0 6 to 1 2 microns. Motile with gella. Gram-negative. Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar slants: Moderate growth along streak, filiform, whitish, glistening.

Broth: Turbid: A pellicle formed. Milk: Becomes alkaline and clears.

Nitrites not produced from nitrates.

Indole not produced in 10 days Slight

amount found later.

No II2S produced.

Acid from glucose, galactose and sucrose. No acid from lactose, maltose and mannitol (Paine and Banfoot, Ann. Appl. Biol., 11, 1924, 312).

Starch not hydrolyzed.

Slight growth in broth plus 7 per cent salt (Burkholder).

Optimum temperature 27° to 28°C. Maximum 34° to 35°C. Minimum below 1°C.

Aerobic.

Source: Isolated from diseased nasturtium leaves from Virginia and diseased beet leaves from Utah.

Habitat: Pathogenic on sugar bcets, nasturtiums, and lettuce.

71. Pseudomonas primulae (Ark and Gardner) Starr and Burkholder. (Phytomonas primulae Ark and Gardner, Phytopath., 26, 1936, 1053; Starr and Burkholder, Phytopath., 32, 1942, 601.) From L. primulus, first; M.L. Primula, a generic name.

Rods: 0.51 to 0.73 by 1.0 to 316 microns. Motile with a polar flagellum. Gram-negative.

Green fluorescent pigment produced in

Gelatin: Liquefaction.

Agar colonies: Round, convex, smooth,

glistening, yellowish. Milk: Coagulated.

Nitrites not produced from nitrates. Indole not produced. No H<sub>2</sub>S produced. Not hpolytic (Starr and Burkholder,

Phytopath., \$2, 1942, 601).

Acid but not gas from glucose, lactose, sucrose, maltose, galactose, arabinose;

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Polyangium, 1031	Streptococcus, 323
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glycerol, dulcitol and mannitol. Starch not hydrolyzed.

Growth in broth plus 5 per cent salt.
Optimum temperature 19° to 22°C.
Maximum 34°C. Minimum 10°C.

Optimum pH 68 to 7.0. Minimum 4.5 to 50.

Facultative anaerobe.

Source: Isolated from leaf-spot of Primula polyantha

Habitat: Pathogenic on Primula spp.

72. Pseudomonas viridilivida (Brown) Holland. (Bacterium eirrditividum Brown, Jour. Agr. Res., 4, 1915, 476; Holland, Jour. Bact., 5, 1920, 225; Phytomonas viriditivida Bergey et al., Manu, 1st ed., 1923, 187) From Latin, viridis, green; lividius, blue.

Rods: 1.0 to 1.25 by 1 25 to 3 0 microns Motile with 1 to 3 polar flagella Gram-

negative.
Green fluorescent pigment produced in culture.

Gelatin: Slow liquefaction

Beel agar colonies: Cream white,

round, smooth, translucent, edges entire Broth: Turbid, becomes lime green Milk: Alkaline and clears.

Nitrites not produced from nitrates

Indole is produced. Not lipolytic (Starr and Burkholder,

Phytopath., 52, 1912, 601).

Acid from glucose and sucrose (Burk-

holder).
Grows well in 4.5 per cent salt. Grows

in 7 per cent salt (Burkholder). Maximum temperature 34.5°C. Mini-

mum 1 5°C

Source: Isolated from diseased lettuce

Habitat: Pathogenic on lettuce, Lac-

73. Pseudomonas delphinii (Smith) Stapp (Bacillus delphini Smith, Science, 19, 1905, 147; Bactrium del phinii Bryan, Jour. Agr. Res., 23, 1921, 201; Stapp, in Sorauer, Handbuch der Plantenkranheiten, 2, 5 Auf., 1925, 105; Phytomonas delphinii Bergey et al., Manual, 3rd ed., 1930, 201.) From Latin, delphin, a dolphin; M.L. Delphinium, a generic name.

Rods: 0.6 to 0.8 by 1.5 to 20 microns. Chains present. Motile with 1 to 6 polar flagella. Capsules. Gram-negative.

Green fluorescent pigment produced in

culture. Gelatin: Liquified.

Beef agar slants. Growth thin, smooth, shining, transparent, margins entire, crystals. Agar becomes dark brown.

Broth: Turbid in 24 hours with delicate pellicle.

Milk. Becomes alkaline and clears. Nitrites not produced from nitrates

Indole not produced.

No II-S produced.

Lipolytic action negative (Starr and Burkholder, Phytopath., 32, 1912, 601). Acid from glucose, galactose and fructose; slightly acid from sucrose. No acid from lactose, maltose, glycerol and mannitol.

Starch. Hydrolysis feeble.

Weak growth in broth plus 4 per cent salt.

Optimum pH 6.7 to 7.1. pH range 5.6 to 8 6

Optimum temperature 25°C. Maximum 30°C. Minimum 1°C or less.

Source: Isolated from black spot of delphinum.

Habitat: Pathogenic on delphinium causing a black spot in the leaves.

74. Pseudomonas berbeitāls (Thornberry and Anderson) Stapp. (Phylomonas berbeitāda Thornberry and Anderson, Jour. Agr. Res., 43, 1931, 36; Stapp. Bot. Rev., J. 1973, 407, Bazterum berbeitāta Burgwitz, Phytopathogenie Beteris, Leningrad, 1935, 133.) From M.L. Berberis, habberry, generic name.

Rods: 0.5 to 1.0 by 1.5 to 2.5 microns, occurring singly or in pairs. Motile with 2 to 4 polar flagella Capsules present.

Gram-negative (Burkholder); not Gram positive as stated in original description. Plant Diseases (continued)
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Green fluorescent pigment produced in culture (Burkholder).

Gelatin: Not liquefied

Glucose agar slants: Growth moderate, filiform at first, later beaded, raised, smooth, white. Butyrous in consistency. Milk: Becomes alkaline. No other

change.

Nitrites not produced from nitrates.
Indole not produced.

No H2S produced.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Acid from glucose, galactose, and sucrose. Maltose and rhamnose not

utilized (Burkholder).

No gas from carbohydrates

Starch not hydrolyzed. Optimum temperature 18°C. Maxi-

mum 30°C. Minimum 7°C.

Aerobic. Sources: Repeated isolations from leaves and twigs of barberry.

Habitat: Pathogenic on barberry, Berberis thunbergern and B. vulgaris.

75. Pseudomonas coronafaciens (Elliott) Stapp. (Baclerium coronafaciens Elliott, Jour. Agr Res. 19, 1920, 153; Phytomonas coronafaciens Bergey et al., Manual, 1st ed., 1923, 180, Stapp, in Sorauer, Handbuch der Pfianzenkrankheiten, 2, 5 Auf., 1928, 20) From L. corona, halo; faciens, producing, referring to the lesions on cat blades

Probable synonyms Elliott (Bact. Plant Pathogens, 1930, 122) lists as synonyms, Bacillus arenae (Russell, Johns Hopkins Univ. Thesis, 1892) and Bacillus arenae Manna and Pseudomonas arenae Manns (Ohio Agr. Exp. Sta. Bul. 210, 1909, 133; Phylomonas arenae Bergey et al., Manual, 3rd ed., 1930, 263.

Rods: 0 65 by 2.3 microns, occurring in chains Motile with polar flagella Capsules. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin Slow liquefaction.

Nutrient agar colonies White, becom-

ing irregularly circular, flat with raised margins.

Broth: Slight turbidity in 21 hours. Heavy pellicle formed.

Milk: Alkaline. A soft curd formed followed by clearing. Curd sometimes absent.

Nitrites not produced from nitrates.

Indole not formed.

No H.S formed.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Acid but no gas from glucose and sucrose. Starch hydrolysis slight.

Slight growth in broth plus 2 per cent salt.

Optimum temperature 24° to 25°C. Maximum 31°C. Minimum 1°C.

Source: Numerous isolations from blighted blades of oats,

Habitat: Causes a halo spot on cats (Arena satira). Artificial inoculations show barley (Hordeum vulgare), rye (Secale cereale) and wheat (Trittcum aestwum) to be susceptible.

75a. Pseudomonas coronafaciens var. atropurpurea (Reddy and Godkin) Stapp. (Bacterium coronafaciens var. atropurpureum Reddy and Godkin, Phytopath., 13, 1923, 81; Stapp, in Sorauer, Handbuch der Pflancnekrankheiten, 2, 5 Auf., 1923, 9, Phytomonas coronafaciens var. atropurpurea Magrou, in Hauduroy et al., Diet. d. Bact Path., Paris, 1937, 371.) From L ater, black, dark; purpureus, purple, referring to the color of the lesion on brome grass.

Distinctive characters: This variety differs from Pseudomonas coronafaciens in that it infects the brome-grass, Bromus inermis, where it produces a water soaked spot which is dark purple in color.

Source: Numerous isolations from diseased brome-grass.

Habitat: Pathogenic on Bromus inermis and Agropyron repens. Has been artificially inoculated on coats, Avena satira.

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76. Pseudomonas lachrymans (Smith and Bryan) Carsner. (Bacterium lachrumans Smith and Bryan, Jour. Agr Res . 5, 1915, 466; Carsner, Jour. Agr. Res . 15. 1918, 15; Bacillus lachrymans Holland. Jour. Bact., 5, 1920, 218; Phytomonas lachrumans Bergev et al . Manual 1st ed . 1923, 184.) From Latin, causing tears, probably referring to the onaque drops formed on the lesion caused by this pathogen.

Synonym · Elliott (Man Bact, Plant Pathogens, 1930, 147) lists the following as a synonym · Bacillus burgeri Potebnia, Khartov Prov. Agr. Exp. Sta., 1, 1915, 37.

Description from Smith and Bryan (loc. cit.) and Clara (Cornell Agr. Exp. Sta, Mem. 159, 1934, 26).

Rods: 08 by 1 to 2 microns Motile with 1 to 5 polar flagella Capsules. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Beef-peptone agar colonies · Circular. smooth, glistening, transparent, whitish, entire margins

Broth: Turbid in 24 hours White precipitate with crystals.

Milk: Turns alkaline and clears.

Nitrites not produced from nitrates. Indole reaction weak.

No H-S produced

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Acid but not gas from glucose, fruetose, mannose, arabinose, xylose, sucrose and mannitol. Alkaline reaction from salts of citric, malic and succinic acid Maltose, rhamnose, lactose, raffinose,

glycerol and saliein not fermented (Clara, loc. est ). Starch partially digested. Not digested

(Clara, loc, cit.) Growth in 3 per cent salt after 12 days

No growth in 4 per cent salt. Optimum temperature 25° to 27°C.

Maximum 35°C. Minimum 1°C Aerobic. Facultative annerobe (Clara, loc. cit ).

Source: Isolated from diseased cucumber leaves collected in New York, Wisconsin, Indiana and in Ontario, Canada, Habitat: Pathogenic on cucumber, Cucumis sativus, and related plants.

77. Pseudomonas maculicola (McCul-Inch) Stevens (Bacterium maculicolum McCulloch, U S. Dept. Agr , Bur. Plant Ind. Bul., 225, 1911, 14: Stevens, The Funzi which cause Plant Diseases, 1913. 28, Phytomonas maculicola Bergey et al., Manual, 1st ed , 1923, 189; Bacterium maccullochianum Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 77) From L maculus, spot: -cola, dweller.

Rods 09 by 15 to 3 microns. Filaments present. Motile with 1 to 5 polar flagella Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Beef-peptone agar colonies: Whitish, circular, shining, translucent, edges entire.

Broth Turbid No ring or pellicle. Milk · Becomes alkaline and clears Nitrites not produced from nitrates Indole production feeble

No H-S formed

Not lipolytic (Starr and Burkholder, Phytopath . 32, 1942, 601)

Acid from glucose, galactose, xylose, sucrose, glycerol, and mannitol. Alkaline reaction from salts of citric, malic, malonic, and succinic acid. Salicin, maltose, and salts of hippuric and tartaric not utilized (Burkholder).

Slight growth in broth plus 4 per cent salt (Erw Smith, Bact Plant Diseases, 1920, 306).

Aerobic

Optimum temperature 21° to 25°C. Maximum 20°C, Minimum 0°C, Source: Isolated from diseased cauli-

flower leaves from Virginia. Habitat: Pathogenic on cauliflower and

cabbage. NOTE: Bacterium maculicola var. japo-

nieum Takimoto, Bul. Sci. Fak. Terkult

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78. Pseudomonas marginata (McCulloch) Stapp. (Bacterium marginatum McCulloch, Science, 54, 1921, 115; Jour, Agr. Res. 29, 1921, 174; Phytomonas marginata Bergey et al., Manual, 1st ed., 1923, 188; Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1928, 56.) From L. marginatus, having a border, probably refers to the definite margin of the colony.

Rods: 0.5 to 0 6 by 0.8 to 1.8 microns. Motile with 1 to 4 bipolar flagella. Cap-

sules. Gram-negative.

Green fluorescent pigment produced in Uschinsky's and Fermi's solutions.

Gelatin: Liquefied.

Agar colonies: White, circular, smooth, translucent, viscid, with definite margins at first thin but later thick and contoured. Surface wrinkled.

Milk: At first slightly acid, then alkaline. Casein digested.

Nitrites not produced from nitrates.

Indole production slight. Hydrogen sulfide production slight. Lipolytic (Starr and Burkholder,

Phytopath., \$2, 1942, 601). Acid but not gas from glucose, lactose,

sucrose and glycerol.

Starch hydrolysis feeble. Growth in 3.5 per cent salt. No growth in 4 per cent salt. pH range, 4.6 to 9.1.

Optimum temperature 30° to 32°C. Maximum 40°C. Minimum 8° to 9°C. Source: Repeatedly isolated from

diseased gladiolus. Habitat: Pathogenic on Gladiolus spp.

and Iris app.

79. Pseudomonas medicaginis Sackett. (Sackett, Science, \$1, 1910, 553; also Colorado Agr. Exp. Sta., Bull. 158, 1910, 11; Bacillus medicaginis Holland, Jour. Bact., 5, 1920, 219; Phytomonas medicaginis Bergey et al., Manual, 1st ed., 1923, 179; Bacterium medicaginis Elliott, Bact. Plant Path., 1930, 162.) From L. medica, ancient Media; M.L. Medicago, a generic name.

Rods: 0.7 by 1.2 microns. Motile with to 4 flagella, Filaments present. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Not liquefied.

Nutrient agar colonies: Growth in 21 hours whitish, glistening.

Broth: Turbid in 24 hours. Pellicle formed. Viscid sediment.

Milk: Becomes alkaline. No change. Nitrites not produced from nitrates.

Indole not produced. No H2S produced.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Starch not hydrolyzed.

No gas from carbohydrates. Acid from sucrose.

Slight growth in broth plus 3.75 per cent salt.

Optimum temperature 28° to 30°. Maximum 37.5°C.

Aerobic.

Source: Isolated from brown lesions on . leaves and stems of alfalfa.

Habitat: Pathogenic on alfalfa, Medicago sp.

79a. Pseudomonas phaseolicola (Burkholder) Dowson. (Phytomonas medicaginis var. phaseolicola Burkholder, Phytopath., 16, 1926, 915; Bacterium medicaginis var. phaseolicola Link and Hull, Bot. Gaz., 83, 1927, 413; Pseudomonas medicaginis var. phaseolicola Stapp and Kotte, Nachrichtenb. f. d. Deutschen Pflanzenschutzdienst, 9, 1929, 35; Dowson, Brit. Mycol. Soc. Trans., 26, 1943, 10.) From L. phaseolus, bean; M.L. Phaseolus, a generic name;-cola, dweller.

puerariae Synonym: Bacterium Hedges. (Phytopath., 17, 1927, 48 and 20, 1930, 140; Phytomonas puerariae Bergey et al., Manual, 3rd ed., 1930, 267.)

Description from Burkholder and Zaleski (Phytopath., 22, 1932, 85).

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<sup>\*</sup>Index prepared by Prof. Robert S. Breed and Mrs. Margaret E. Breed, New York State Experiment Station, Geneva, New York, June, 1947.

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Rods: 1 by 2 microns, sometimes slightly curved, filaments present. Motile with polar flagellum Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin stab: Slow liquefaction.

Beef extract agar Whitish, circular colonies, 2 mm. in diameter Edges entire.

Broth: Turbid.

Milk: Alkaline.

Nitrites not produced from mitrates.

Indole not formed.

Hydrogen sulfide not formed

Not lipolytic (Starr and Burkholder, Photopath , 82, 1942, 601).

Acid but no gas from glucose, fructose, mannose, arabinose, xylose, sucrose and glycetol. No acid from rhamnose, lactose, maltose, mannitol and salicin Alkali from salis of citire and malic acids, but not from acetic, formic, lactic or tartaric acids. Starch and cellulose not hydrolyzed.

blight growth in broth plus 4 per cent

Optimum temperature 20° to 23°C.

Maximum 33°C. Minimum 25°C.

(Hedges. loc cit.).

Optimum pH 6.7 to 7.3. Maximum 8 8 to 9.2. Minimum 5 0 to 5 3. (Kotte, Phyt. Zeitsch, 2, 1930, 453.)

Micronerophilie

Source: Isolated from leaves, pod and stem of beans showing halo blight.

Habitat: Pathogenic on beans (Phascolus vulgaris), the kudzu vine (Pueraria hirsula) and related plants

50. Pseudomonas pisi Sackett. (Sackett, Colorado Agr. Exp. Sta., Bull 218, 1916, 19; Bacterium pusi Erw. Smith, An Introduction to Bacterial Diseases of Plants, 1920, 474; Phylomonas pisi Bergey et al., Manual, 1st ed., 1923, 181.) From Gr. pisum, the pea; M.L. Pisum, a generic name.

Rods: 0.68 to 226 microns. Motile with a polar flagellum, Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar slants: Moderate growth in 24 hours, filiform, glistening, grayish-white. Broth: Turbid with a seum in 5 days.

Milk: Alkaline, soft curd, clears

Nitrites not produced from nitrates.

Indole not produced.

No II2S produced.

Not hipolytic (Starr and Burkholder, Phytopath., 52, 1942, 601).

Acid but notgas from glucose, galactose and sucrose.

Starch not hydrolyzed.

Optimum temperature 27° to 28°C Maximum 37.5°C. Minimum 7°C.

Source: Ten cultures isolated from 5 collections of diseased peas showing water soaked lesions on stems and petioles.

Habitat: Pathogenic on garden peas, Pisum sativum and field peas, P. sativum var arvense.

81. Pseudomonas syringae van Hall. (Kennis der Bakter. Pflanzenizieke, Inaug Diss., Amsterdam, 1902, 191; Bacterium syringae Erw. Smith, Baateria in Relation to Pflant Diseases, I, 1905, 63; Phylomonas syringae Bergey et al., Manual, 3rd ed., 1930, 257.) From Latin, syringa, a nymph that was changed into a reed; M.L. Syringa, a generic name

Synonyms: Bryan (Jour. Agr. Res., 36, 1928, 225) lists Bacterium etriputaelte C. O. Smith, Phytopath., 3, 1913, 60, and Bacterium eitrarefaciens Lee, Jour. Agr. Res., 9, 1917, 1 (Pseudomonas eitrarefaciens Stapp, in Sorauer, Handb d. Pflanzenkrankheiten, 2, 5 Aufl, 1923, 190). Clara (Cornell Agr. Cyp. Sta.

vignae Bergey et al., Manual, 1st ed., 1923, 188), Pseudomonas riridifaciens Tisdale and Williamson, Jour Agr. Res., 25, 1923, 141 (Bacterium viridifaciens Tisdale and Williams, tbid.; Phytomonas avium (Bacıllus), 400 avium (Bacterium), 674 avium (Borreliota), 1229 avium (Mycobacterium), 878, 879, 880 nvium (Pasteur, lla), 547 avium (Rickettsia), 1095 avium (Strongyloplasma), 1229 avium (Tarpeia), 1274 azoticus (Bacillus), 772, 824 Azotobacter, 19, 21, 26, 29, 31, 216, 219, azotobacter (Bacıllus), 219 azotogena (Pseudomonas), 697

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viridifaciens Bergey et al., Manual, 2nd ed., 1925, 208), and Phytomonas vignae var. leguminophila Burkholder, Cornell Agr. Exp. Sta. Mem. 127, 1930, 51. Wilson (Phytopath., \$0, 1940, 27) lists Phytomonas cerasi (Griffin) Bergey et al. (Pseudomonas cerasus Griffin, Science, 34, 1911, 615; Bacillus cerasus Holland, Jour. Bact., 5, 1920, 217; Bergey et al., Manual, 3rd ed., 1930, 262; Bacterium cerasi Elliott, Bact. Plant Pathogens, 1930, 109.) This would include, therefore the following synonyms which have been listed for Phytomonas cerasi, Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 25) lists Bacterium trifoliorum Jones et al. (Jour. Agr. Res., 25, 1923, Phytomonas trifoliorum 471: holder, Phytopath., 16, 1926, 922; Pseudomonas trifoliorum Stapp, in Sorauer, Handb. d. Pflanzenkrankheiten, 2, 5 Aufl., 1928, 177) and Bacterium holci Kendrick (Phytopath., 16, 1926, 236; Pseudomonas hole: Kendrick, 1bid.; Phytomonas holci Bergey et al., Manual, 3rd ed. 1930, 258). Wilson (Hilgardia, 10, 1936, 213) lists Pseudomonas prunicola Wormald (Ann. Appl. Biol., 17, 1930, 725), Pseudomonas cerasi var prunicola Wilson (Hilgardia, 8, 1933, 83), Bacterium citriputeale C. O Smith (Phytopath., 4, 69; Pseudomonas citriputealis 1913. Stapp, in Sorauer, Handb d. Pflanzenkrankheiten, 2, 5 Aufl , 1928, 190; Phytomonas citriputcalis Bergey et al , Manual, 3rd ed., 1930, 278) and Pseudomonas utiformica Clara, Science, 75, 1932, 111 (Phytomonas utiformica Clara, Cornell Agr. Exp Sta. Mem. 159, 1934, 29; Bacterium utiformica Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 444). A is Phytomonas probable synonym spongiosa (Aderhold and Ruhland) Ma-(Bacillus spongiosus Aderhold and Ruhland, Cent f. Bakt., II Abt., 15, 1905, 376; Pseudomonas spongiosa Braun, Die Landwirtschaft, 41, 42, 1927, 2 pp; Bacterium spongiosum Elliott, Man. Bact. Plant Pathogens, 1930, 214; Magrou, in Hauduroy et al., Diet. d. Bact. Path , Paris, 1937, 414). C. O. Smith

(Phytopath., 38, 1913, 82) lists the following as a synonym: Pseudomonas hibisei (Nakata and Takimoto) Stapp (Baclerium hibisei Nakata and Takimoto, Ann. Phytopath. Soc. Japan, 1, 5, 1923, 18; Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 5 Aufl., 2, 1928, 203; Phytomonas hibisei Bergey et al., Manuals 3rd ed., 1930, 264).

Description from Clara (loc. cit.).

Rods: 0 75 to 1 5 by 1.5 to 3 0 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Beef-extract agar colonies: Circular, grayish-white with bluish tinge. Surface smooth. Edges entire or irregular.

Broth: Turbid in 36 hours. No pelli-

Milk: Alkaline.

Nitrites not produced from nitrates.

Indole not produced.

No HaS produced.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601).

Slight growth in broth plus 4 per cent salt.

Acid but not gas from glucose, galactose, mannose, arabinose, xylose, sucrose, mannitol and glycerol. Alkaline reaction from salts of citric, malic, succinic and lactic acid. Rhamnose, maltose, lactose, raffinose, salicin, and acctic, formic and tartaric acid not fermen'ed.

Starch not hydrolyzed.

Facultative anaerobe. Source: Van Hall originally isolated the pathogen from hlac.

Habitat: Pathogenic on lilac, citrus, cow peas, beans, lemons, cherries and many unrelated plants.

81a. Orsini reports the following as a variety—Bacterium syringae var. capsic Orsini. (Intern. Bull Plant Prot., 53, 1942, 33) Pathogenic on the pepper plant (Capsicum).

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Rods: 06 by 1 to 2.7 microns. Long chains formed in culture Capsules present. Motile with 1 to 4 polar or bipolar flagella. Gram-negative

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Beef-peptone-agar colonies Circular, shining, translucent, white

Broth: Growth never beavy, slight

rim, and a delicate pellicle
Milk: Becomes alkaline and clears
Nitrites not produced from nitrates

Indole: Slight production

Hydrogen sulfide: Slight production Acid and no gas from glucose, galactose and sucrose.

Starch is slightly hydrolyzed

Optimum temperature 25° to 28°C Maximum 36° to 37°C and minimum below 2°C.

Aerobic.

Sources: Isolated from diseased wheat grains collected throughout United States and Canada.

Habitat: Causes a basal glume-rot of wheat.

83. Pseudomonas cumini (Kovaceviki) Dowson (Phylomonas cumini Kovucevski, Bull. Soc. Bot Bulgarie, 7, 1936, 27; Donson, Trans. Brit. Mycol. Soc., 28, 1913, 10) From Greek cuminum, cumin; M. L. Cuminum, a generic name

Rods: 0.5 to 0.7 by I to 3 microns, occurring in chains and filaments. Motile with 1 to 3 polar fligella. Gram-negative

Green fluorescent pigment formed in culture.

Gelatin: Rapidly liquefied

Potato agar colonies: Grayish-white, circular, glistening, smooth, butyrous Broth: Moderate turbidity. Pseudoroeloca. Milk: Not coagulated Casein peptonized.

Nitrites not produced from nitrates Indole not formed.

Acid but not gas from glucose and sucrose. No acid from lactose or glycerol. Starch not hydrolyzed

Temperature range 5°C to 31°C.

Acrobic.

No II-S formed.

Source: Isolated from blighted cumin (Cuminum)

Habitat: Pathogenic on cumin and dill.

81 Pseudomonas desalana (Burholder) comb. nov. (B. pyocyaneus saccharum Desai, Ind. Jour. Agr. Sci., 5, 1935, 391, Phytomonas desarana Burkholder, in Bergey et al., Manual, 5th ed., 1939, 174) Named for Desa who first isolated the species.

Rods 0 6 to 1.2 by 1.2 to 2.2 microns. Motile with a polar flagellum. Gramnegative.

Green fluorescent pigment produced in culture

Gelatin: Liquefaction.

Agar colonies: Grayish-blue. Italsed. Broth Light clouding. Pelliele.

Milk Peptonized without congulation, Nitrites not produced from nitrates,

Indole not formed. Glucose, sucrose, luctose and glycerol

fermented without gas.
Starch Hydrolysis present

Optimum temperature 30°C.

Source. Isolated from stinking rot of sugar cane in India and associated with a white non-pathogenic bacterium.

Habitat. Pathogenie on sugar cane, Saccharum oficinarum.

85 Pseudomonas erodii Lewie. (Phytopath., 4, 1914, 231; Bacterium erodii. Lewis, ibid; Phytomonas erodii Bergey et al., Manual, 3rd ed., 1930, 256.). From Greek, erodius, heron; M.L. Erodium, a generic name.

Rods. 06 to 08 by 1.2 to 18 microns.

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Motile with 1 to 3 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar stroke: Heavy, smooth, creamcolored growth in 24 hours. Broth: Dense clouding in 24 hours.

Milk: Turns alkaline and clears, litmus reduced. Nitrites not produced from nitrates.

Indole produced in 14 days. No H.S produced.

Acid but not gas from glucose, sucrose,

lactose and glycerol. Temperature: No growth at 35°C.

Aerobic, obligate.

Source: Isolations from Erodium texanum and 4 varieties of Pelargonium. Habitat: Causes a leaf spot of Erodium texanum and Pelargonium spp.

86. Pseudomonas apil Jagger. (Jagger, Jour. Agr Res., 21, 1921, 186; Phytomonas apı: Bergey et al., Manual, 1st ed., 1923, 184; Pseudomonas jaggeri Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Aufl , 1928, 210; Bacterium jaggeri Elliott, Bacterial Plant Pathogens, 1930, 142, Phytomonas jaggers Magrou, in Handuroy et al., Dict. d. Bact. Path . Paris, 1937, 371.) From Latin, anum, parsley, M.L. Apium, a generic name.

Description from Clara (Cornell Agr. Exp. Sta. Mem. 159, 1934, 24).

Rods: 0.75 to 1.5 by 1.5 to 3.0 microns Motile with a polar flagellum. Gram-

negative.

Green fluorescent pigment produced in various media.

Gelatin: Liquefaction.

Beef-extract agar colonies. Circular, glistening, smooth, edges entire

ish-white with bluish tinge Broth: Turbid in 36 hours. Pellicle formed.

Milk: Becomes alkaline. No curd

Nitrites not produced from nitrates Indole not formed.

No H.S formed.

Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xylose, sucrose, mannitol and glycerol. Alkaline reaction from salts of acetic. citric, malic and succinic acids. Rhamnose, maltose, lactose, raffinose, salicin, and formic, lactic and tartaric acid are not utilized

Starch not hydrolyzed.

Facultative anaerobe.

Distinctive characters: Pathogenicity

appears limited to celery.

Source: Jagger isolated this repeatedly from diseased celery leaves.

Habitat: Pathogenic on celery, Apium aravcolens.

87. Pseudomonas matthiolae (Briosi and Pavarino) Dowson, (Bacterium matthiolae Briosi and Pavarino, Atti della Reale Accad, dei Lincei Rend., 21, 1912, 216; Phytomonas matthiolae, Bergey et al., Manual, 3rd ed., 1930, 266; Mushin, Proc. Roy. Soc. Victoria, 53, 1941, 201; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 10.) From M.L. Matthiola, a generic name.

Rods: 0.4 to 0.6 by 2 to 4 microns. Gram-positive. Gram-negative (Mushin. loc. cit.).

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Beef agar colonies: White, circular colonies, slightly elevated, marrins smooth.

Broth: Slightly turbid. Becomes pale green.

Milk: Coagulation with acid react on-Nitrites produced from nitrates (Mushin).

Hydrogen sulfide not formed.

Acid from glucose, galactose, fructose, mannose, rhamnose, glycerol, mannitol, acetic acid, citric acid, formic acid, lactic acid, malic acid, and succinic acid. Feeble acid in maltose. No acid. no gas in lactose, sucrose, raffinose, starch, salicin, and tartaric acid (Mushin).

Optimum temperature 20 to 24°C.

fermentans (Flavobacterium), 172 fermentans (Pseudomonas), 172 fermentatae (Lactobacillus), 358 fermentationis (Achromobacter), 424 fermentationis (Bacillus), 655 fermentationis (Bacterium), 424 fermentationis cellulosae (Bacillus), 809 fermenti (Lactobacıllus), 359, 350 fermenti (Micrococcus), 340 fermenti (Streptococcus), 340 fermentosus (Wesenbergus), 534 fermentum (Lactobacterrum), 360 ferophilum (Bacterium), 677 ferrarii (Pacinia), 690 ferrigenus (Bacillus), 743 ferruginea (Cellulomonas), 620 ferruginea (Chlamydothrix), 831 ferruginea (Didymohelix), 831 ferruginea (Gaillonella), 831 ferruginea (Gallionella), 831, 832 ferruginea (Gloeotila), 831 ferruginea (Itersonia), 1044 ferruginea (Nocardia), 975 ferruginea (Spirochaete), 831 ferruginea (Spirulina), 831 ferruginea (Toxothrix), 984

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granulobacter pectinovorum (Bacillus),

Maximum temperature 38.5 C. Minimum below 0°C. (Mushin).

Limits of growth in broth are pH 4.4 to pH 9.5 (Mushin).

Aerobic.

Source: Isolated from vascular and parenchymatic disease of stocks, Matthiola incana var. annua.

Habitat: Pathogenic on stocks

Nors: Burkholder (Phytopath, 28, 1938, 936) and Santarelli (Rev. dt Pat Veg., 29, 1939, 364) consider this species a synonym of Pseudomonas syringae. Adam and Pugsley (Jour Dept. Agric Victoria, 32, 1934, 306) give a description of a green fluoresecut pathogen on stocks which is similar to Pseudomonas syringae. Mushin (loc. cit.) considers Pseudomonas matthiolae to be a distinct species.

 Pseudomouas mors-pruncum Wormald. (Jour. Porn and Hort. Ser. §, 1931, 291; Phylomonas mors-pruncrum Wormald, Trans. Brit. Mycol. Soc., 17, 192, 109; Baclerium mors-pruncrum, 181d.) From L. mors, death, prunus,

plums.

Rods: Motile with a polar flagellum.

Gram-positive (1931) Gram-negative

(1932).
Note: Possibly a green fluorescent orgraism since it produces a faint yellow

color in Uschinsky's solution

Gelatin: Liquefaction.

Agar colonies: White.

Broth plus 5 per cent sucrose; White and cloudy.

Nitrites not produced from nitrates Acid but not gas from glucose, lactose, sucrose and glycerol

Starch not hydrolyzed

Strict acrobe.

Distinctive characters: Differs from Pseudomonas prunscola (Pseudomonas prunscola (Pseudomonas syringos) in that it produces a white cloudy growth in broth plus 5 per cent success; a rapid acid production in nutrient gara plus 5 per cent success, and a faint yellow or no color in Uschinsky's solution.

Source: Isolated from cankers on plum trees in England.

Habitat: Pathogenic on Prunus spp.

Pseudomonas rimaefaciens Koning.
 (Chron. Bot., 4, 1938, 11; Meded. Phytop. Labor, Willie Comm. Scholt., 14, 1938,
 From L. rima, fissure; faciens, producing.

Rods: 06 to 2.4 microns in length. Motile with 1 to 3 polar flagella. Gram-

negative.

Yellow-green fluorescent water-soluble pigment produced in culture.

Gelatin: Liquified.

Agar colonies: Round, convex, smooth, somewhat granular with hyaline edge. Broth: Turbid. Surface growth with a sediment in a few days.

Milk: Alkaline and clears.

Nitrites not produced from nitrates Peptone, asparagin, urea, gelatin, nitrates and ammonia salts are sources of nitrogen

Hydrogen sulfide not produced,

Indole production slight.

Groath with the following carbon sources plus NO<sub>1</sub>, glucese, Sucrose, glycerol, succinates, malates, citrates and ovalates. Less growth with mannitol, fructose, galactose, lactose, salicylate Actu as produced from the sugars No growth with dectrin, inulin, maltose, lactose, rhumpose, salicin, tartrates, acctates, formates.

Starch not hydrolyzed.

Aerobic

1930, 218).

Optimum temperature 23°C. Matimum about 37°C. Very slow growth at 14°C. Thermal death point 42° to 45°C. Source: Strains of the pathogen isoated from poplar cankers in France and in the Netherlands.

Habitat: Pathogenie on Populus brabantica, P. trichocarpa and P. candicana. This may be Pseudomonas syringae since the characters are the same and both organisms can infect Impatiens sp. Pseudomonas syringae infects poplars Giliott. Bacterial Plant Pathogens.

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Pseudomonas papulans ltore. (Rose, Phytopath., 7, 1917, 198; Phytomonas papulans Bergey et al., Manual, 3rd ed , 1930, 267; Bacterium papulans Elliott, Bacterial Plant Pathogens, 1930, 175; Phytomonas syringae var, papulans Smith, Jour. Agr. Res., 68, 1911, 291.) From L. papulans, forming blisters,

Rods: 0 6 by 0 9 to 2 3 microns. Motile with I to S polar flagella. Gram-nega-

Green fluore scent pigment produced in culture.

Gelatin: Liquehed

Broth. Moderate turbidity in 21 hours. Milk: Alkaline and at times a roft congulum.

Nitrates not produced from nitrates. Indole: May or may not be produced. Acid but not gas formed from glucose and sucrose

Optimum temperature 25° to 28°C. Maximum 37°C

Source Twenty five cultures isolated from blisters on apples and from rough bark.

Habitat Pathogenic on apple trees.

Pseudomonas pseudozoogloeae (Honing) Stapp (Bacterium pseudozooglocae Honing, Bull. van Het. Deli Proefstation, Medan, 1, 1911, 7, Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf , 1928, 271; Phytomonas pseudozooglocae Bergey et al. 3rd ed , 1930, 261.) From Gr , pseudo, false; M. L. zoogloea, zooglea. Rods: 0.7 to 1 5 by 0 9 to 2 5 microns.

Chains. Mottle with 1 or 2 polar flagella. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin Liquefaction.

Agar colonies. Round, flat, yellowcray.

Broth: Moderate turbidity with pseudozoogloca in the pellicle

Milk. Coagulation. No clearing.

Nitrites not produced from nitrates Indole not formed

Hydrogen sulfide produced

Acid but not gas from glucose, lactose, maltore, sucrose and mannitol.

Lacultative anaerobe.

Source: Isolated from the black rust of toleron.

Habitat: Pathogenic on tobacco. Nicotiana Iabacum.

972. Pseudomonas tabaci (Wolf and Poster) Stevens, (Bacterium tabacum Wolf and Poster, Science, 46, 1917, 362; also Jour, Agr. Res . 12, 1918, 449; Phytomonas tabaci Bergey et al., Manual, 1st ed., 1923, 185; Stevens, Plant Disease Fungi, New York, 1925, 31.) From Nicotiana tahacum, tobacco.

Rods: 1.2 by 3.3 microns. Motile with

a polar flagellum. Gram-negative. Gelatin: Liquelaction.

Potato agar colonica: Grayish-white, circular, raised, wet-shining, smooth.

Milk: Alkaline: clears.

Nitrites not produced from nitrates.

Indole not formed.

Acid from glucose, galactose, fructose, I-ambinose, xylose, sucrose, pectin, mannited and glycerol (Braun, Phytopath, 27, 1937, 289)

Ammonium sulfate, potassium nitrate, eystine, glutamic acid, glycine, succinimide, oxamide, acetamide, and urea can be used as nitrogen source (Braun).

Starch not hydrolyzed. Aerobic. Distinctive character: Braun (loc. cit.) states that Pseudomonas tabaci and Pseudomonas angulata are identical in culture.

Source: Isolated from wildfire lesions on tobacco leaves in North Carolina. Habitat: Pathogenic on tobacco, Nico-

tiana tabacum.

93 Pseudomonas lapsa (Ark) Burkholder. (Phytomonas lapsa Ark, Phytopath., 30, 1910, 1; Burkholder, ibid., 52, 1942, 601.) From Latin, lapsus, falling, referring to a symptom of the disease.

Rods: 0.56 by 1.55 microns. Motile with 1 to 4 polar flagella.

Produces fluorescence in Uschinsky's Fermi's, and Cohn's solutions.

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Gelatin: Liquefied (Burkholder).

Acid but no gas is produced from glucose, sucrose, maltose, lactose, glycerine, arabinose, vylose, galactose, raffinose and mannitol.

Slight growth in broth plus 5 per cent salt (Burkholder). Source: Isolated from stalk rot of field

corn in California; also from Digbrotica beetles

Habitat. Pathogenic on corn and sugar Note: Like Pseudomonas desiana.

91. Pseudomonas bowlesiae (Lewis and Watson) Dowson. (Phytomonas bowlesis Lewis and Watson, Phytopath, 17, 1927, 511; Bacterium bowlesis Elliott, Bacterial Plant Pathogens, 1930, 96, Dowson, Trans. Brit Mycol Soc. 26, 1943, 9) From M. L. Boulesia, a generic

name. Rods: 05 to 07 by 12 to 16 microns, occurring singly, in pairs or in short chains. Motile with bipolar flagella. Gram-negative

Green fluorescent pigment produced in culture.

Gelatin: Liquefied. Agar slants. Yellowish, moist, glisten-

ing and vised Broth: Uniform turbidity throughout Heavy viscous sediment in old cultures Milk: Alkaline; coagulation, with a

slow peptonization. Nitrites are produced from nitrates.

Indole is produced.

Hydrogen sulfide is produced

Acid from glucose, maltose and xylose, No acid from sucrose.

Optimum temperature 27°C. Maximum 37°C. Minimum -1°C.

Optimum pH 72, pH range 4 5 to 8 6. Aerobic

Source: Isolated from diseased, water soaked spots of bowlesia.

Habitat: Pathogenic on Bowlesia septentrionalis.

95. Pseudomonas Intvbi (Swingle) Stapp (Phytomonas intybi Swingle, Phytopath., 15, 1925, 730; Stapp, in Soraurer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf , 1928, 291: Bacterium intub: Elliott, Bacterial Plant Pathorens. 1930, 142.) From Latin, intibus, endive

Description from Stapp, Cent f. Bakt.. II Abt., 91, 1935, 232,

Rods · 0.4 to 0.5 by 1.4 to 2.8 microns. Motile with one to several polar flagella. Gram-negative.

Green fluorescent pigment formed in culture.

Gelatin: Liquefaction.

Agar colonies: White, glistening, transparent

Broth, Turbid with fragile pellicle. and good sediment.

Milk: Coagulated. Casein not peptonized.

Nitrates are produced from nitrates with the formation of gas.

Indole not formed.

Acid but not gas from arabinose, xylose and glucose. No acid from sucrose

Optimum temperature 23° to 28°C. Maximum 40° to 42°C. Minimum 0°C. Distinctive character: Differs from

Pseudomonas cichorii in that it liquefies gelatin and produces natrites from nitrafes.

Source · Isolated from French endive. Cichorium intybus by Swingle, from C. endira and lettuce, Lactuca sativa by Stapp.

Habitat: Pathogenic on endive and lettuce, causing a rot.

96. Pseudomonas marginalis (Brown) Stevens (Bacterium marginale Brown, Jour Agr. Res., 15, 1918, 386, Phytomonas marginalis Bergey et al., Manual, 1st ed . 1923, 182, Stevens, Plant Disease Fungi, New York, 1925, 30) From Latin, margo (marginis), edge, margin; M.L. marginalis, on the margin, a character of the disease.

Description from Brown (loc. cit.) and Clara (Cornell Agr. Exp. Sta Mem. 159, 1934, 27).

Rods: Motile with 1 to 3 polar flagella, Gram-negative.

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Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Agar colonies: Cream-colored to vellowish.

Broth: Turbid, with pellicle.

Milk · Alkaline. Soft curd at times. Nitrates are produced from nitrates. Not produced (Clara, loc. cit.)

Indole not produced.

No H2S produced.

Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xylose, rhamnose, mannitol and glycerol. Alkali from salts of acetic, citric, malic, formic, lactic, succinic and tartaric acid. Sucrose, maltose, lactose, raffinose and salicin not fermented (Clara, loc. cit.).

Starch hydrolysis feeble. None (Clara, loc. cit.).

Ontimum temperature 25° to 26°C. Maximum 38°C. Minimum 0°C.

Aerobic

Source: Isolated from marginal lesion on lettuce from Kansas.

Habitat: Pathogenic on lettuce and related plants

Pseudomonas setariae (Okabe) comb. nov. (Bacterium setariae Okabe, Jour. Soc. Trop. Agr. Formosa, 6, 1934, 63; Phytomonas setariae Burkholder, in Bergey, Manual, 5th ed., 1939, 183.) From L. seta, bristle; -arius, like; M. L. Setaria, a generic name.

Rods: 0.4 to 0 8 by 1.8 to 4.4 microns. Motile with a polar, seldom bipolar, flagellum. Gram-negative.

Yellowish water-soluble pigment produced in culture.

Gelatin: Slow liquefaction.

Beef-extract agar colonies Circular,

white, opalescent, smooth, glistening. Broth: Turbid after 18 hours. Pel-

Milk: Alkaline; clears.

Nitrites are produced from nitrates. Indole is produced.

No H.S produced.

Acid but not gas from glucose, galac-

tose and glycerol. No acid from lactose. maltose or sucrose.

Starch: Feeble hydrolysis.

Grows in 3 per cent salt.

Optimum temperature 31° to 34°C. Maximum 42°C.

Aerobic

Source: Isolated from brown stripe of Italian millet.

Habitat: Pathogenic on Italian millet, Setaria italica

Pseudomonas polycolor Clara. (Clara, Phytopath., 20, 1930, 704; Phytomonas polycolor Clara, ibid., Bacterium polycolor Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 148.) From Gr. poly, many; L. color, color.

NOTE: Delacroix (Comp. rend. Acad. Sci., Paris, 137, 1903, 454) describes Bacillus acrogenosus as being a tobacco pathogen. The organism described by Delacroix might be the same as Pseudomonas polucolor. Braun and Elrod (Jour. Bact., 48, 1942, 40) are of the opinion that Clara's pathogen is Pseudomonas aeruginosa.

Description taken from Clara (Cornell Agr. Evp. Sta. Mem. 159, 1934, 28).

Rods: 0.75 to 1.2 by 1.05 to 3.0 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction.

Beef-extract agar colonies: Grayishwhite, circular, raised, thin transparent margins.

Broth: Turbid in 36 hours with thin pellicle.

Milk: Alkaline; no curd.

Nitrites not produced from nitrates Indole not produced.

No H.S produced.

Lipolytic (Starr and Burkholder, Phytopath., \$2, 1942, 601).

Acid but not gas from glucose, galactose, fructose, mannose, arabinose, xylose, mannitol and glycerol. Alkaline reaction from salts of acetic, citric, malic,

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lactic and formic acid. Rhamnose, sucrose, maltose, lactose, raffinose and salicin not fermented.

Starch not hydrolyzed.

Facultative angerobe.

Good growth in broth plus 7 per cent salt.

Optimum temperature 25° to 30°C Maximum 37° to 39°C.

Distinctive character. Differs from Pstudomonas mellea in type of lesion produced, does not digest starch, nor reduce nitrates and does not form acid from lactoses nor sucrose. Pathogenic for laboratory animals (Elrod and Braun, Sci. 94, 1941, 520).

Source: Repeatedly isolated from leaf spot of tobacco in the Philippines.

Habitat: Pathogenic on tobacco

Pseudomonas viridiflava (Burkholder) Clara (Phytomonas viridiflara Burkh, Cornell Agr. Exp. Sta Mem 127, 1950, 63; Clara, Science, 75, 1954, 111; Bacterium siridiflavum Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 127; From Latin viridis, green; flavus, yellow.

Description from Clara (Cornell Agr. Exp. Sta. Mem. 139, 1934, 30).

Rods. 0 75 to 1 5 by 1.5 to 3.15 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin · Liquefaction.

Beef-extract agar colonies Grayishwhite, margins corrugated, edges irregular.

Broth: Turbid in 36 hours.

Milk: Becomes alkaline and clears. Nitrites not produced from nitrates Indole not formed.

No H<sub>2</sub>S produced.

Not lipolytic (Starr and Burkholder, Phytopath , 32, 1942, 601).

Acid but not gas from glucose, fructose, mannose, arabinose, vylose, mannitol and glycerol. Alkaline reaction from salts of acetic, citric, malic, lactic and succinic acids. Sucrose, lactose, maltose, raffinose, salicin, and salts of formic and tartaric acids not fermented.

Starch: No hydrolysis.

Growth in broth plus 5 per cent NaCl Facultative anaerobe.

Facultative anaerob

Source: Two cultures isolated from spotted beans, one from England and one from Switzerland.

Habitat · Pathogenic on bean, Phaseolus vulgaris.

99a Pseudomonas viridiflara var concentrica (Petersen) comb. nov. (Phylomonas viridiflara var. concentrica Petersen, Tridisskr f. Planteavl., 33, 1932, 851, Bacterium viridiflavim var concentricum Burgwitz, Phytopathogenic Bacteria, Lenungrad, 1935, 127.) From M. L. concentricus, concentric, referring to the rings on the colonies

Distinctive characters: Differs from Pseudomonas viridifava in that it does not grow in Uschinsky's solution, and also in the shape of the colonies.

Source Isolated from the stems and leaves of blighted beans in Denmark.

Habitat. Pathogenic on the bean, Phaseolus vulgaris.

100. Pseudomonas ananas Serrano (Serrano, Philipp. Jour. Sci. 55, 1934, 355; Phylomonas ananas and Bacterium ananas Serrano, tibid. (not to be confused with Erunnia ananas Serrano, tibid., 56, 1923, 271); Bacterium serranos Burgaitz, Bact. Dis. of Plants, Leningrad, 1936.) From Brazilian Indian, ananas, pineapple; M L Ananas, generic name.

Rods . 0 6 by 1 8 microns. Motile with 1 to 4 polar flagella. Gram-negative.

Green fluorescent pigment produced in certain media.

Gelatin: Liquefied.

Beef-extract glucose agar colonies: White, with undulating edges, smooth to rugose, glistening to dull.

Beef-extract agar. Growth scant. Broth: Feeble growth.

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Jam (Bacterium), 603 racemosum (Flavobaciersum), 603 Milk · Becomes alkaline with curd. Nitrites not produced from nitrates. Indole not formed.

No H2S formed

Acid but not gas from glucose, xylose and mannitol. Feeble with lactose. No icid with sucrose.

Starch not hydrolyzed.

Optimum temperature 30° to 31°C. Maximum 45°C. Minimum 7° to 10°C. Aerobic.

Habitat: Causes a rot of pincapples, Ananas comosus.

101. Pseudomonas ligustri (d'Oliveira) :omb nov. (Bacterium ligustri d'Oliveira, Revista Agron., 24, 1936, 434.) From L. ligustrum, privet; M. L. Ligus-

rum, a generic name. Rods 05 to 0.7 by 13 to 3 microns. No chains. No capsules. Motile with to 5 polar flagella. Gram-negative. Green pigment produced on Dox agar.

and in broth. Gelatin. Liquefied

Beef-extract agar colonies:

noderate. Milky white, circular, convex. Broth. Turbid in 24 hours. No pelicle.

Milk Coagulated in 6 days, and later digested. Litmus slightly acid. Nitrites not produced from nitrates

Indole not produced.

Ammonia not produced.

No gas from carbohydrates Acid from glucose, galactose, arabinose and mannose. No acid from sucrose, maltose, actose, raffinose, mannitol and salicin

Source: From diseased Japanese privet in Lisbon, Portugal.

Habitat: Pathogenic on privet, Ligustrum japonicum.

102. Pseudomonas sesami Malkoff. (Malkoff, Cent f Bakt, II Abt., 16, 1906, 665; Bacterium scsami Nakata, Ann. Phyt. Soc. Japan, 2, 1930, 242; Phytomonas sesami Kovachersky, Ann. Univ. de Sofia, Fac. Agron , 8, 1930, 464.) From Gr. sesamum, sesame; M. L. Sesamum, a generic name.

Synonym: Nakata (loc. cit.) lists Bacterium sesamicola Takimoto, Jour. Plant Protect. Tokyo, 8, 1927, 433 (Phytomonas sesamicola Magrou, in Hauduroy ct al., Dict. d. Bact. Path , 1937, 412).

Description from Nakata (loc. cit.). Rods: 0.6 to 0 8 by 1.2 to 3.8 microns. Motile with 2 to 5 polar flagella. Gramnegative.

Green fluorescent pigment produced in

Gelatin: Liquefaction rapid.

Beef-agar colonies: Circular, flat, striate, smooth, entire margins, white.

Broth: Growth rapid. No pellicle. Milk: Alkaline, No coagulation. Nitrites not produced from nitrates. Indole not produced.

No H.S produced.

Acid but not gas from glucose. No acid from lactose, sucrose or glycerol. Starch not hydrolyzed.

Optimum temperature 30°C. Maximum 35°C. Minimum 0°C. Facultative anaerobe.

Source: Isolated from brown spots on leaves and stems of sesame.

Habitat: Pathogenic on sesame

Pseudomonas tolaasii Painc. (Paine, Ann. Appl. Biol., 5, 1919, 210; Phytomonas tolaasi Bergey et al., Man ual, 3rd ed., 1930, 259; Bacterium tolaasi Elliott, Bacterial Plant Pathogens, 1930, 226.) Named for A. G. Tolaas who first reported the species.

Rods: 0.4 to 0.5 by 0.9 to 1.7 microns. Motile with 1 to 5 polar flagella. Gramnegative.

Green fluorescent pigment produced in

Gelatin: Liquefaction.

Bouillon agar: Streak develops in 24 hours, dirty bluish-white, wet-shining and slightly raised.

Broth: Turbid in 24 hours. Pellicle. Milk: Becomes alkaline and clears Nitrites not produced from nitrates. Indole production slight.

Acid but not gas from glucose. No acid from lactose or sucrose.

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Starch hydrolysis feeble.

Optimum temperature 25°C.

Isolated in England from brown-spot of cultivated mushrooms

Habitat: Pathogenic on cultivated mushrooms.

Pseudomonas xanthochlora (Schuster) Stapp (Bacterium zanthochlorum Schuster, Arbeit a d Kaiserl Biolog. Anstalt, f. Land. u. Forstw., 8, 1912, 452; Phytomonas xanthochlora Bergey et al., Manual, 1st ed., 1923, 180, Stapp, in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1928, 213) From Gr. xanthus, yellow, chlorus, green

Description from Erw Smith, Bacteria in Rel. to Plant Dis , 3, 1914, 272

Rods 075 to 15 by 30 microns tile with 1 to 3 flagella. Gram-negative Green fluorescent pigment produced in

culture Gelatin: Slow liquefaction

Agar colonies. Circular, slightly raised, sellon -n hite.

Broth. Strong clouding in 24 hours A white pellicle

Milk: Slow coagulation and clearing Nitrites are produced from nitrates

Indole is produced after 10 days Hydrogen sulfide produced slowly

Acid but not gas from glucose and galactose. Optimum temperature 27°C Maxi-

mum 44°C. Minimum 2°C Source Isolated from rotting potato

tubers in Germany.

Habitat, Pathogenic on potato tubers and a number of unrelated plants

105 Pseudomonas rhizoctonia (Thom ns) comb. nov. (Aplanobacter rhizoctonia Thomas, Oluo Agr. Exp. Sta. Bull. 359, 1922, 211; Bacterium rhizoclonia Stapp, in Sorager, Handbuch der Pflanzenkrank heiten, 2, 5 Auf., 1928, 200, Phytomonas rhizoctonia Burkholder, Phytopath , 20, 1920, 7.) From Gr. rhizo, noot; etonue, murder.

Rods, 0.5 to 0.85 by 1.4 to 1.9 microns Non motile. Gram negative

Green fluorescent pigment produced in culture.

Gelatin: Liquefaction

Nutrient agar colonies Greenish-yellow, later olive-buff, circular, raised, slightly viscid.

Broth. Turbid, pyrite yellow Milk · Alkaline; clears

Nitrites are produced from nitrates Indole reaction very slight

No H-S formed

Starch: Potato starch slightly hydrolyzed

Growth in S per cent salt.

Optimum temperature 25° to 27°C. Maximum 38°C Minimum 0°C Source Isolated from roots of lettuce

showing the rosette disease

Habitat: Pathogenic on roots of lettuce

106. Pseudomonas barkeri (Berridge) Clara (Bacillus of pear blossom disease, Barker and Grove, Ann. Appl. Biol . 1, 1914, 91; Barker and Grove's organism, Doidge, Ann Appl. Biol , 4, 1917, 50. B barkers Berridge, Ann. Appl Biol, 11, 1924, 73; Phytomonas barkers Bergey et al , Manual, 3rd ed , 1930, 265; Bacterium barkeri Elhott, Bacterial Plant Pathogens, 1930, 95; Clara, Science, 75, 1934, 11 ) Named for B. T. P Barker

Description from Doidge (loc cit.) Reds 05 to 08 by 2 to 4 microns Motile with 1 to 1 polar flagella Gramnegative (Burkholder), not Gram-positive as stated

who first reported the species

Green fluorescent pigment produced in culture.

Gelatin Liquefaction

Ager Growth is white, feeble, Pit, glistening, smooth edged

Broth Slightly turbed in 21 hours

Milk Flowly cleared Natrites not produced from natrates

Indole not formed unless culture narmed. Starch Flowly digested, Source Barker made many cultures

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from blighted pear blossoms. Doidge received a culture from Barker.

Habitat: Causes a blossom blight of pear.

107. Pseudomonas gladioli Severini. (Severini, Annalı d. Bot., Rome, 11, 1913, 420; Bacterum gladioli Elliott, Bact. Plant Pathogens, 1930, 132; Phytomonas gladioli Magrou, in Hauduroy al., Diet. d. Bact Path, Paris, 1937, 336.) From L. gladiolus, a little sword; M. L. Gladiolus, a generic name.

Rods: 06 by 23 to 2.8 microns. Motile with one or more polar flagella. Gram-negative.

A pale yellow water-soluble pigment

found, later orange.
Gelatin colonies. Cream-colored, wart-

Milk: Coagulated and slowly peptonized.

Nitrites not produced from nitrates.

Indole not formed.

No gas.

like. Rapid liquefaction.

Aerobic.

Optimum temperature 28° to 30°C.

Habitat: Causes a corm rot of gladiolus
and other tubers

108. Pseudomonas meilea Johnson. (Bacterium meileum Johnson, Jour. Agr. Res., 23, 1923, 489, Johnson, loc. cit., 489; Phylomonas meilea Bergey et al, Manual, 3rd ed., 1930, 251.) From L. meileus, of or belonging to honey, the color of the colonies.

Rods: 06 by 1.8 microns. Capsules Motile with 1 to 7 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Liquefied.

Potato - glucose agar: Abundant growth, smooth, glistening, viscid, honey-

colored

Broth: Turbid in 24 hours. Pellicle

Milk: Alkaline; clears.

Nitrites not produced from nitrates Indole not formed. No H2S formed.

Starch hydrolysis feeble.

Growth inhibited by 4 per cent salt.

Optimum temperature, 26° to 28°C.

Maximum 36°C.

Facultative anaerobe.

Distinctive character: Differs from Pseudomonas pseudozoglocae in that it produces on tobacco a brown instead of a black spot with a halo, is orange-yellow in culture, and turns milk alkaline. Source: Isolated from brown rusty

Source: Isolated from brown rusty spots on tobacco in Wisconsin.

Habitat: Pathogenic on leaves of tobacco. Nicotiana tabacum.

109. Pseudomonas betlis (Ragunathan) comb. nov. (Bacterium betle Ragunathan, Ann. Roy. Card., Peradeniya, Ceylon, 11, 1923, 51; Aplanobacter betle Elliott, Bact. Plant Pathogens, 1930, 4; Phylomonas betlis Magrou, in Hauduroy et al., Dict. d. Bact. Path., Paris, 1937, 337.) From Malayan, betle, betel, a kind of pepper, Piper betle.

Rods: 0.5 by 1.5 to 2.5 microns, occurring singly or in short chains. Nonmotile. Gram-negative.

Green pigment formed in nutrient gelatin and in broth.

Gelatin: Liquefaction.

Bovril agar colonies: Honey-yellow, circular at first, later echinulate. Raised, smooth and shiny.

Broth: Surface becomes cloudy in 2 days. Pellicle.

No gas from lactose, maltose or sucrose. Starch is reduced.

Aerobic.

Source: Five cultures isolated from leaf spots on the betel vine.

Habitate Pethogenic on the betel vine.

Habitat: Pathogenic on the betcl vine, Piper betle.

110. Pseudomonas panacis (Takimoto) Dowson. (Bacterium panazi Nakata and Takimoto, Bul. Agr. Sta. Chosen, 8, 1922, 1; Phytomonas panazi Magrou, in Hauduroy et al., Diet. d. Bact. Path., Paris, 1937, 339; Dowson, Trans. Brittranslucens f. sp. secalis (Xanthomonas), 162 translucens f. sp. undulosa (Xanthomonas), 162 translucens var. phlespratensis (Xanthomonas), 703 translucens var. secalis (Bacterium), 162 translucens var. secalis (Phytomonas), 162 translucens var. secalis (Pseudomonas), 162 translucens var, undulesa (Phytomonas), translucens var. undulosa (Pseudomonas). translucens 'var, undulosum (Bacterium), 162 transvalensis (Actinomyces), 906 transvalensis (Nocardia), 906 trapanicum (Bacterium), 412 trapanicum (Flavobacterium) (Halabacterium), 442 trautweinii (Thiobacillus), 81, 688 tremaergasius (Bacillus), 670 tremelloides (Bacıllus), 442 tremelloides (Bactersum), 412 tremelloides (Flavobacterium), 442 tremulans (Bacillus), 688 tremulans (Bacterium), 688 tremulans (Vibrio), 688 Treponema, 12, 19, 20, 26, 28, 34, 35, 1071 treubii (Siderocapsa), 833 tributyrus (Micrococcus), 279 tricalle (Treponema), 1076 Trichobacterium, 28 trichodectae (Rickettsia), 1097 trichogenes (Leptothrix), 984 trichoides (Bacillus), 576 trichordes (Bacterordes), 576 trichoides (Ristella), 576 trichorrhezidis (Bacterium), 658 Trichothecrum ap., 919 tricolor (Actinomyces), 935 tricomsi (Bacillus), 757

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Mycol. Soc., 26, 1943, 10.) From Gr. panax (panicis), a plant heal-all: M. L. Panax, a generic name

Description from Elliott, Bact Plant

Pathogens, 1930, 173. Rods: 0 5 by 1 3 to 1.5 microns Chains.

Motile with 4 to 6 polar flagella. Gramnegative.

Green fluorescent pigment produced in culture.

Gelatin: Slight liquefaction

Agar colonies: White Milk: Coagulated.

No gas from sugars.

Habitat: Causes a root rot of genseng, Panax quinquefolium.

111. Pseudomonas aleuritidis (McCulloch and Demarce) Stapp (Bacterium aleuritidis McCulloch and Demarec, Jour. Agr. Res., 45, 1932, 339, Stapp, Bot Rev., 1, 1935, 408; Phytomonas alcuritidis Magrou, in Hauduroy et al , Diet d. Bact. Path., Paris, 1937, 328 ) From Gr. alcurites, of wheaten flour, M. L. Aleurites, generic name.

Rods: 06 to 07 by 1.1 to 3 microns. Motile with 1 to 5 polar, rarely bipolar, flagella. Capsules present. Gram-nega-

tive. Green fluorescent pigment produced in certain media.

Gelatin · Not liquefied.

Beef agar slants: Growth is thin, white

and viscid. Broth: A heavy white surface growth

in 21 hours. Sediment. Milk: Becomes alkaline, but no sep-

aration.

Nitrites are produced from nitrates

Indole test feebly positive Hydrogen sulfide test feebly positive

Acid but no gas from glucose, galactose and giveerol. Slow acid production from sucrose, maltose and lactose

Starch hydrolysis feeble.

Optimum temperature 27° to 25°C. Maximum temperature 37°C. Optimum till 6.2 to 6.8 pll range 54

to \$ 9.

Source: Isolations from naturally infected tung oil trees in Georgia.

Habitat. Pathogenic on the tung oil tree (Aleurites fordi), on the bean (Phaseolus vulgaris) and the castor bean (Ricinus communis).

112. Pseudomonas glycinea Coerper. (Bacterium alucineum Coerner, Jour. Agric. Research, 18, 1919, 188; Coerper, loc. cit. 188; Phytomonas alucinea Burkholder, Phytopath., 16, 1926, 922) From alucus, sweet; ine, like: M.L. Glycine, generic name.

Synonym: Bacterium sojae Wolf, Phytopath, 10, 1920, 132 (Phytomonas sojae Burkholder, Phytopath , 16, 1926, 922; Pseudomonas some Stapp, in Sorauer. Handb d. Pflanzenkrankheiten, 2. 5 Aufl , 1928, 174). See Elliott, Bact. Plant Pathogens, 1930, 134; and Shunk

and Wolf. Phytopath., 11, 1921, 18. Rods: 12 to 1.5 by 23 to 3 microns. Motile with polar flagella. Gram-nega-

Green fluorescent pigment produced in culture.

Gelatin: Not liquefied.

Beef-peptone agar colonies: Appear in 24 hours. Circular, creamy white, smooth, shining and convex. Margins entire. Butyrous in consistency.

Milk, Litmus turns blue and later a separation of the milk occurs. Casein not digested.

Nitrites not produced from nitrates

Indole test feebly positive. Not lipolytic (Starr and Burkholder,

Phytopath , 32, 1912, 601). Starch not hydrolyzed.

Acid from glucose and sucrose

Optimum temperature 21° to 25°C. Maximum 35°C. Minimum 2 C l'acultative anaerobe.

Source: A number of cultures isolated from soy beans in Wisconsin.

Habitat: Pathogenie on soybean, Glyeine max (Soja max).

1124. Pseudomonas glycinea var japonica (Takimoto) comb. nor (Barverose (Corynebacterium), 386, 401 zerosis (Bacıllus), 386 xerosis (Baclerium), 386 zerosis canis (Bacillus), 406 rerosis canis (Corynebacterium), 406 zerosis variolae (Bacillus), 401 zylanicus (Bacıllus), 758 xylina (Ulvina), 692 velinoides (Bacterium), 187, 693 xylinoides (Ulvina), 693 xylinum (Actobacter), 181, 182, 187, 692 zulinum (Bacterium), 181, 187 xylinus (Bacıllus), 692 xylitica (Vibrio), 207 xylophagus (Bacıllus), 758 xylosus (Lactobacillus), 363 yasakı: (Vibrio), 702 yersini (Coccobacillus), 549 Yersinia, 550, 703 zaoreb (Salmonella), 504 zanzibar (Salmonella), 524 Zaogalactina 479 zeae (Bacıllus), 457 zeae (Bacterium), 457

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zeylanicus (Spirobacillus), 218 zevlanicus (Vibrio), 218 zingiberi (Bacterium), 171 zingiberi (Phytomonas), 171 zingiberi (Pseudomonas), 171 zingiberi (Xanthomonas), 171 zinnioides (Bacterium), 690 zirnii (Bacillus), 758 zlatogorovi (Spirochaeta), 1070 zonatus (Amnulus), 1212, 1213, 1214, 1217 zonatus (Bacıllus), 672 zonatus (Micrococcus), 281 zoodysenteriae (Bacıllus), 791 200d usenters as hungaricus (Bacillus), 791. zooepidemicus (Streptococcus), 316 zoogleicum (Clostridium), 797 zoogleiformans (Bacterium), 577 zoogleiformans (Capsularis), 577 Zoogloea, 348 zopfi (Helikobacterium), 608 20pfi (Streptothrix), 977 Zopfiella, 705 zopfii (Bacillus), 603 zopfu (Bacterium), 608 zopfii (Kurihia), 608 zopfii (Zopfius), 608 zophi (Bacterium) (Proteus), 608 Zopfius, 42, 608 zörkendörferi (Bacıllus), 672 zörkendörferi (Pseudomonas), 150 Zuberella, 33, 34, 577 zuernianum (Bacterium), 690 zuernianus (Bacillus), 690 zuntzıs (Clostridium), 822 Zygoplagia, 12, 13, Zygostasis, 12, 13, 705 Zymobacillus, 30, 705 zymogenes (Coccobacillus), 672 zymogenes (Micrococcus), 327 zymogenes (Staphylococcus), 327 zymogenes (Streptococcus), 327 Zymomonas, 29, 30 Zymosarcina, 29, 30, 31, 235 zymoseus (Bacillus), 672 zythi (Streptococcus), 345

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terium soyae var. japonicum Takimoto, Jour. Plant Protect. Tokyo, 14, 1927, 556; Bacterium glycineum var. japonicum Elliott, Bact Plant Pathogens, 1930, 136; Phytomonas glycinea var. japonica Magrou, in Hauduroy et al., Diet d. Bact. Path., Paris, 1937, 358.) From M. L. Japonicus, japaneso

Distinctive characters: Differs slightly from Pseudomonas glycinea in size of cell, length of chains, action in milk, and color in meda Okabe (Jour. Soc. Trop. Agr., Formosa, 6, 1033, 102) gives a description of the organism which leads one to believe the differences are not great enough to be varietal.

Source · Isolated from leaf spots on soy bean in Formosa.

Habitat. Pathogenic on soy bean, Gly-

113. Pseudomonas savastanol (Erw. Smith) Stevens (Bacterium savastanoi Erw Smith, U.S. Dept. Agr. Plant Ind. Bull 131, 1908, 31; Stevens, The Fungi which Cause Plant Diseases, 1913, 33; Phytomonas savastanoi Bergey et al, Manual, 1st ed, 1923, 190.) Named for F. Savastano, the Italian plant pathologist.

Norn: Smith (loc cit.) lists and discards the following species since they were either mixed cultures or names with no descriptions. Bacterium oleae Arcangeli, Isitt. Bot. delle R. Univ di Pisa, Ricerche e Lavori, fase 1, 1886, 100, Bacilus oleae tuberculosis Savastano, Atti R. Accad Naz Lineei Rend. Cl. Sc. Fis., Mat e Nat. 6, 1889, 92; Bacillus prilleuxianis Trevisan, I generi e le specie delle Batteriacee, Milano, 1889, 10; Bacillus oleae De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 982.

Description from Brown, Jour. Agr Res , 44, 1932, 711.

Rods 04 to 08 by 12 to 33 microns Motile with 1 to 4 polar flagella. Gramnegative

Green fluorescent pigment found in culture

Gelatin: No liquefaction.

Beef agar colonies: White, smooth, flat, glistening, margins erose or entire. Broth: Turbid on the second day. No pellicle or ring.

Milk: Becomes alkaline.

Nitrites not produced from nitrates. No H<sub>2</sub>S produced.

Acid but not gas from glucose, galactose and sucrose.

Starch is hydrolyzed

Optimum temperature 23° to 24°C. Maximum 32°C. Minimum 1°C.

Optimum pH 6.8 to 7.0. Maximum 8.5. Minimum 5 6.

Aerobic.

Source: Smith isolated his cultures from olive galls collected in California. Habitat: Pathogenic on olive.

113a. Pseudomonas savastanoi var. frazini (Brown) Dowson. (Bacterium savastanoi var. frazini Brown, Jour. Agr. Res., 44, 1932, 721; Phytomonas savastanoi var. frazini Magrou, in Hauduroy et al. Diet d. Bact. Path., Paris, 1937, 410; Pseudomonas frazini Skorie, Ann Exp. For. Zagreb, 6, 1938, 66; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 11.) From M. L. Frazinus, a generic

name.
Distinctive characters: Differs but slightly from Pseudomonas savastanoi, but is pathogenic on ash and not on olive.

Source: Three cultures isolated from cankers on ash.

Habitat: Pathogenic on ash, Frazinus excelsior and F. americana.

114. Pseudomonas tonelliana (Ferraris) comb. nov. (Bacterium tonellianum Ferraris, Trattato di Patologia e Terapia Vegetale, 3rd ed., I, 1925, 191; Phytomonas tonelliana Adams and Pugaley, Jour. Dept. Agr. Victoria, 32, 1934, 304.)
Named for Tonelli, the Italian botanist.

Synonym: Pseudomonas savaslanos var. neru C. O Smith, Phytopath., 18, 1928, 503.

Description from Smith (loc. cit.) unless otherwise noted. Rods: 0.5 to 0 6 by 1 5 to 2.5 microns Motile with 1 to 3 polar flagella. Gramnegative (Adams and Pugsley, loc. cit).

Gelatin: No liquefaction.

Potato glucose agar colonies: Flat, circular, shining, margins somewhat undulated.

Broth Dense clouding with partial pellicle.

Milk: Alkaline. No separation

Nitrites not produced from nitrates (Adams and Pugsley).

Indole produced. Not produced (Adams and Pugsley). Acid but not gas from glucose and

Acid but not gas from glucose and sucrose. No acid from lactose (Adams and Pugsley).

Starch not hydrolyzed (Adams and Pugsley).

Distinctive character: Pseudomonas satastanos is similar in culture but is not rathogenic on cleanders.

Source: Both Ferraris and C O. Smith isolated the pathogen from galls on oleander.

Habitat: Pathogenic on oleander, Nerum oleander.

115. Pseudomonas calendulae (Takimoto) Dowson. (Bacterium calendulae Takimoto, Ann. Phytopath Soc Japan, 5, 1936, 311; Phytomonas calendulae Burkholder, in Manual, 5th ed. 1939, 201; Dowson, Trans. Brit. Mycol. Soc. 26, 1913, 9.) From Latin, calendae, throughout the month; M. L. Calendula, a generic name. Rods: 0.5 by 1 to 2 microns. Motile

with 1 to 3 polar flagella Gram-negative.

Green fluorescent pigment produced in Uschinsky's and in Cohn's solutions

Gelatin: Not liquefied.

Agar colonies: Circular, smooth, flat,

dirty white. Broth: Turbid.

Milk: No congulation

Nitrates not produced from nitrates Indole formed in small amount.

No H.S produced.

Acid but not gas from glucose and glycerol. No acid from lactose or sucrose.

Starch not hydrolyzed

Optimum temperature 27° to 30°C. Maximum 37°C. Minimum 0° to 7°C.

Habitat. Pathogenic on marigolds, Calendula officinalis.

116 Pseudomonas cichorii (Swingle) Stapp. (Phytomonas cichorii Swingle, Phytopath, 15, 1925, 730; Stapp, n. 80auer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1923, 201; Bacterium cichorii Elliott, Bact. Plant Pathogens, 1930, 112) From Gr cichoria, chicory; M. L. Geborum, reperen annu, reperen annu

Probable synonyms \* Pseudomonas endruae Kotte, Phyt. Ztschr , 1, 1930, 609; Phytomonas endurae (Kotte) Chra, Cornell Agr. Lyp Sta Mem 159, 1934, 26; and Bacterum formosanum Okabe, Jour Soc. Trop. Agr., Formosa, 7, 1935, 65

Description from Clara (loc etc.) which is a description of a culture of Pseudomona; endurae from Kotte. Swingle's description is very meager.

Rods 075 to 15 by 15 to 375 microns, Motile with 1 or 2 polar flagella. Gramnegative.

Green fluorescent pigment produced

Gelatin: No liquefaction.

Beef-extract agar colonies. Circular, grayish-white with blush tinge, raised with slightly irregular edges. Broth: Turbed in 36 hours with a

Broth Turbed in 36 hours with a smooth viscous pellicle.

Milk Alkaline

Nitrites not produced from nitrates, Indole not formed.

No II,S formed.

Not lipolytic (Starr and Burkholder, Phytopath , 52, 1912, 601).

Acid but not gas from glucose, galactose, fructose, manuose, ambinose, vylose, mannitol and glycerol. Alkaline production from salts of acetic, citric, lactic, malic, succinic and tartaric acids. Rhamnose, maltose, sucrose, lactose, raffinose and salicin not utilized.

Starch not hydrolyzed.

Slight growth in broth plus 6 per cent NaCl. Optimum pH 6.8 to 7.1. Maximum

9.2 to 9.4. Minimum 5.0 to 5.3 (Kotte, Phyt. Ztsch., 2, 1930, 453).

Facultative anaerobe,

Distinctive characters: Differs from Pseudomonas intybi in that it does not liquefy gelatin or reduce nitrates to nitrites.

Source: Isolated from rot of French endive, Cichorium intybus by Swingle and by Okabe, and from C. endivia by Kotte.

Habitat: Pathogenic on endive, lettuce and larkspur.

117. Pseudomonas cissicola (Takimoto) comb. nov. (Aplanobacter cissicola Takimoto, Ann. Phytopath. Soc. Japan., 9, 1939, 43.) From Greek, crssus, ivy; M. L. Cissus a generic name.

Rods 0.5 to 0.9 by 10 to 20 microns.

Non-motile. Capsules. Gram-negative.

Green fluorescent pigment formed in

Uschinsky's solution.

Gelatin: No liquefaction.

Potato-extract agar colonies: Circular, convex, smooth, and dirty white.

Broth: Feeble clouding followed by precipitation of pellicle and rim.

Nitrites not produced from nitrates.
Indole not formed.

Hydrogen sulfide not produced.
No acid nor gas from sucrose, glucose.

lactose and glycerol. Starch is not digested.

Salt toleration is 3 per cent.

Optimum temperature 30°C. Maximum 35°C. Minimum 10°C. Thermal death point 49° to 50°C.

Source: Isolated from black spots on leaves of Japanese ivy, Cissus japonica in Japan. Habitat. Pathogenic only on Cissus

japonica

118. Pseudomonas nectarophila (Doidge) Rosen and Bleeker. (Racterium nectaraphila Doidge, Ann. Appl. Biol., 4, 1917, 73; Phylomonas nectaraphila Bergey et al., Manual, 3rd ed., 1930, 262; Rosen and Bleeker, Jour. Agr. Res., 46, 1933, 98.) From Gr. nectar, nectar; philus, loving.

Rods: 0.5 to 0.7 by 0.6 to 1.5 microns.

Motile with 1 to 5 polar flagella. Capsules. Gram-negative.

Green fluorescent pigment produced in culture.

Gelatin: No liquefaction.

Nutrient agar colonies: Yellowishwhite, wet-shining, smooth, margins irregular.

Broth: Heavy turbidity in 24 hours. Sediment.

Milk: Cleared.

Nitrites not produced from nitrates.

Indole not formed.

Acid from glucose and galactose. No acid from sucrose.

Starch hydrolysis feeble.

Optimum temperature 25 to 30°C.

Facultative anaerobe.

Distinctive character: Differs from Pseudomonas barkeri in that it does not liquefy gelatin, nor produce indole. Produces capsules.

Source: Isolated from blighted pear blossoms in South Africa.

Habitat: Pathogenic on pear blossoms.

119. Pseudomonas viburni (Thornberry and Anderson) Stapp. (Phylomonas viburni Thornberry and Anderson, Phytopath., 21, 1931, 912; Stapp, Bot. Rev., I, 1935, 407; Bacterium viburni Burgwitz, 1935, 160.) From L. viburnum, the wayfaring tree; M. L. Viburnum, a generic name.

Rods: 05 to 1.0 by 1 to 2.0 microns. Capsules present. Motile with 2 to 4 polar flagella. Gram-negative (Burkholder); not Gram-positive as stated.

holder); not Gram-positive as stated.

Green fluorescent pigment produced in culture (Burkholder).

Gelatin: No liquefaction.

Glucose beef-extract colonies: Dull gray, circular, edges entire.

Broth: Turbid with pellicle. Milk: Alkaline.

Nitrites not produced from nitrates

Indole not formed. No ILS formed.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 601)

Acid from glucose and galactose, but not sucrose (Burkholder).

Starch: No hydrolysis.

Slight growth in 3.5 per cent salt (Burkholder).

Optimum temperature 25°C. Minimum 12°C. Maximum 35°C.

Aerobic.

Source: Isolated from angular leaf spots and stem lesions on arrow-wood, Viburnum opulus, etc

Habitat: Pathogenic on Viburnum spp.

120. Pseudomonas mori (Boyer and Lambert) Stevens. (Bacterium mori Boyer and Lambert, Compt. rend. Acad Sci. Paris, 117, 1893, 342; Bacterium mori Boyer and Lambert emend. Erw Smith, Science, \$1, 1910, 792, Stevens, The Fungi which Cause Plant Diseases, 1913, 30, Bacillus mori Holland, Jour Bact, δ, 1920, 222; Phytomonas mori Bergey et al , Manual, 1st ed., 1923, 191.) I'rom Gr. morum, mulberry; M. L. Morus, a generic name

Synonyms: Elliott (Bact. Plant Pathogens, 1930, 166) lists Bacillus cuboniunus Macchiati, Staz. Sperim Agr Ital , 25, 1892, 228 (Macchiati described the disease due to Pseudomonas mors, but gave an incorrect description of the pathogen); also Bacterium cubonianum Ferraris, Curiano le Plante, 6, 1928, ISO (Perraris uses Macchiati's name but the description of Pseudomonas mort).

Description from Smith (loc. cit ) Rods: 09 to 1.3 by 1.8 to 4.5 microns. Motile with a polar flagellum. Gram-

negative Green fluorescent pigment produced in culture.

Gelatin: Not liquefied Agar colonies: White, slow growing,

smooth, flat, edges entire becoming un-

Milk: Becomes alkaline and clears. Nitrites not produced from nitrates. Indole none or feeble production.

Hydrogen sulfide not produced (Okabe, Jour. Soc. Trop. Agr., δ, 1933, 166).

No growth in broth plus 4 per cent salt (Okabe, loc, cit.).

No gas from carbohydrates.

Temperature range 1°C to 35°C. Source: Smith isolated the pathogen from blighted shoots of mulberry from Georgia. Also received cultures from

Arkansas and the Pacific Coast. Habitat: Pathogenic on mulberry, Morus.

121. Pseudomonas stizolobii (Wolf) comb. nov. (Aplanobacter stizolobii Wolf. Phytopath., 10, 1920, 79; Bacterium stizolobii McCulloch, Phytopath , 18, 1928, 460: Phytomonas stizolobii Bergey et al.. Manual, 3rd ed , 1930, 280.) From Gr. stizo, to prick; lobium, a little lobe; Sitzolobium, a generic name.

Rods: 0.6 to 0.7 by 1 0 to 1.6 microns. Non-motile (Wolf). Motile with a short polar flagellum (McCulloch). Capsules. Gram-negative.

Gelatin: No liquefaction.

Agar colonies · Circular, smooth, white, raised and opaque. Margins entire to slightly undulate.

Broth: Slightly turbid throughout. No nellicle or ring.

Milk: Alkaline.

Natrites not produced from nitrates. Indole not formed.

No acid or gas in peptone broth plus sugars.

Starch not hydrolyzed.

Ontimum temperature 25° to 25°C.

Distinctive characters: Differs from Pseudorionas sojae (Pseudomonas cl.jcinea) in the smaller size of cell, and absence of pellicle and dense clouding of broth. The pathogen does not infect soy bean.

Source: Isolated from the leaf spot of velvet bean.

Habitat: Pathogenic on velvet bean, Stitolobium deeringianium.

Pseudomonas viciae Uveda. (Uyeda in Takimoto, Jour. Plant Protect . Japan. 2, 1915, 845; Bacterium viciae Nakata, see Elliott, Bact, Plant Pathogens, 1930, 259; Phytomonas viciae Magrou, in Hauduroy et al., Dict d. Bact. Path , Paris, 1937, 430.) From L. vicia, vetch; M. L. Vicia, a generic name. Rods. 0 5 to 0.8 by 1.2 to 2.0 microns.

Motile with 2 to 4 polar flagella. Grampositive.

Green fluorescent pigment produced in culture.

Gelatin colonies: Pale white, glistening, finally turning brown. No liquefaction

Milk Coagulates and clears.

Nitrites not produced from nitrates. No H2S produced.

Facultative anaerobe.

Habitat Pathogenic on the broad bean (Vicia faba), the turnip (Brassica rapa), the carrot (Daucus carota) and the sweet potato (Ipomoea batatas).

123 Pseudomonas alliicola Burkholder. (Burkholder, Phytopath., 32, 1942, 146, Phytomonas allucola Burkholder, abid ) From L. allium, onion; -cola, dweller.

Rods 07 to 14 by 1.05 to 2.8 microns Motile with 1 to several polar flagella, at times bi-polar. Gram-negative

Gelatin. Liquefaction.

Beef-extract peptone agar streaks: Moderate in growth, white at first, later dirty in appearance, edges wavy, consistency viscid Medium deep brown.

Potato-glucose agar frequently becomes greenish

Broth. Turbid with light pellicle. Brown.

Milk · Cleared and litmus reduced. Neutral.

Nitrites produced from nitrates. Indole not produced.

Hydrogen sulfide not produced.

Lipolytic action very strong

Acid but no gas from 1-arabinose, d-Aylose, rhamnose, glucose, d-galactose, fructose, d-lactose, maltose, sucrose, glycerol, mannitol and salicin. Alkali from salts of acetic, citric, formic, hippurie, lactie, malie, succinic, tartarie acids.

Starch not hydrolysed.

Slight growth in broth plus 4 per cent

Aerobic.

Optimum temperature 30°C. Maximum 41°C, Minimum 5°C. Source: Seven isolates from storage

rot of onion bulbs.

Habitat: Pathogenic on onion bulbs, Allium cepa.

Pseudomonas gardeniae Burkholder and Pirone. (Burkholder and Pirone, Phytopath., \$1, 1941, 194; Phytomonas gardeniae Burkholder and Pirone, abid.) From M. L. Gardenia, a generic name.

Rods: 0.75 by 2.4 microns. Motile with 1 to 2 polar flagella. Gram-nega-

Gelatin: Liquefaction. Beef-extract peptone agar colonies: Growth fair, white to dirty gray and vis-

eid. Medium becoming dark brown. Potato-glucose agar: No brown color. Broth: Turbid with pellicle. Dark

brown. Milk: Soft curd with pellicle. Clears in zones. Litmus reduced.

Nitrites produced from nitrates.

Hydrogen sulfide not produced. Indole not formed.

Acid from glucose, galactose, xylose, rhamnose, sucrose, maltose, mannitol, glycerol, and salicin. Alkali produced from the salts of citric, malic, malonic, succinic, tartaric and hyppuric acids. Good growth in tyrosine and in asparagine broth.

Starch is not hydrolyzed.

Aerobic.

Source: Eight isolates from leaf spots of gardenias in New Jersey.

Habitat: Pathogenic on leaves of Gardensa jasminoides.

125 Pseudomonas caryophylli Burkholder. (Burkholder, Phytopath., \$1, 1941, 143; Phytomonas caryophylli, Burkholder, sbid.) From M. L. Caryophyllus, an old generic name.

Rods: 0.35 to 0.95 by 1.05 to 3.18 microns. At times slightly curved. Motile with 1 to several polar flagella. Frequently bipolar. Gram-negative.

Gelatin: Liquefaction after 3 to 4 weeks.

Potato glucose agar colonies 3 to 4 mm in diameter, circular, smooth, glistening, edges entire. Color is tan to gray mauve. Old culture dark brown Consistency butyrous.

Broth: Turbid with a white sediment Milk: Litmus slowly becomes blue Slight reduction at bottom of tube. No

clearing.

Nitrites produced from nitrates ammonia and gas are produced in a synthetic nitrate medium. Asparagine, KNO2 and NH4H4PO4 can be utilized

Indole not formed.

Hydrogen sulfide not formed.

Lipolytic action slight to moderate Acid from 1-arabinose, d-xylose, rhamnose, glucose, d-galactose, fructose, dlactose, maltose, and sucrose, glycerol, mannitol, and salicin. Alkali with sodium salts of acetic, citric, formic, hippurie, lactic, malic, maleic, succinic and tartaric acid.

Starch not hydrolyzed.

Aerobic.

Optimum temperature 30° to 33°C. Maximum 46°C. Minimum 5°C. or less Slight growth in broth plus 3 5 per cent

salt. Source: Isolated first by L. K. Jones and later by W H. Burkholder from dying carnation plants from Spokane, Washington. Twelve isolates used in

description. Habitat: Pathogenic on roots and stalks of the carnation. Dianthus caryophyllus.

126. Pseudomonas solanacearum Erw. Smith. (Bacillus solanacearum Erw. Smith, U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 12, 1896, 10; Bacterium

solanacearum Chester, Ann. Rept Del. Col. Agr. Exp. Sta , 9, 1897, 73; Erw. Smith, Bacteria in Relation to Plant Discases, 3, 1914, 178; Phytomonas solanacearum Bergey et al , Manual, 1st ed., 1923, 186.) From L solanum nightshade, M. L. Solanaceae, a plant family.

Probable synonyms Elliott (Bact. Plant Pathogens, 1930, 203) lists the following · Bacillus nicotianae Uveda. Cent f. Bakt, II Abt, 13, 1904, 327; Bacillus sesami Malkoff and Pseudomonas sesami Malkoff, Cent. f. Bakt., II Abt , 16, 1906, 664; Bacillus musae Rorer, Phytopath , 1, 1911, 45; Bacillus musarum Zeman, Rev. Facul, Agr. Umv., La Plat, 14, 1921, 17, Erwinia nicotianae Bergey et al., Manual, 1st ed., 1923, 172; Phytomonas ricini Archibald, Trop. Agr., Trinidad, 4, 1927, 124

Description taken from Elliott (loc cit). Rods: 0 5 to 1 5 microns. Motile with

a polar flagellum. Gram-negative.

Gelatin Nakata (Jour Sc. Agr. Soc. Tokyo, 294, 1927, 216) states there are two forms, one of which shows slight liquefaction The other shows no liquefaction

Agar colonies Small, 11regular, roundish, smooth, wet-shining, opplescent, becoming brown.

Broth: Slight pellicle Broth turns brown.

Milk: Cleared without precipitation of casein.

Nitrates produced from nitrates.

Indole not formed

Hydrogen sulfide not produced (Burkholder)

Glucose, sucrose, glycerol, sodium

1938, 325).

Nitrogen sources utilized are ammonia, nitrates (KNO:) asparagine, tyrosine, peptone and glutamic acid, but not potassium nitrite (Mushin, loc, cit.).

Starch not hydrolyzed.

Garden, 9, 1922, 383; Bacterium alboprecipilans Elliott, Bact. Plant Path, 1930, 89; Phylomonas alboprecipilans Bergey et al., Manual, 3rd ed., 1930, 277.) From Latin albus, white and precipilans, precipitating, referring to the white precipitate produced in culture.

Rods: 06 by 1.8 microns, occurring singly or in pairs. Capsules present. Motile with a polar flagellum. Grampeentive.

Gelatin. Not liquefied.

Nutrient agar colonies. White, circular, raised, smooth, sticky, with margins entire. Whitish discoloration of the medium.

Broth: Turbid in 24 hours. Heavy sediment in old cultures. Milk: Becomes alkaline and slowly

clears

Nitrites produced from nitrates.

Indole not produced No II<sub>2</sub>S produced.

Acid but not gas from glucose, fructose, glycerol and mannitol. No acid from lactose, maltose or sucrose.

Starch is hydrolyzed

Optimum temperature 30° to 35°C. Maximum temperature 40°C. Minimum 0°C.

Acrobic

Distinctive characteristics. White precipitate in culture media.

Source: Isolated a number of times from foxtail grass.

Habitat Pathorenic on foxtail Chartes

Habitat . Pathogenic on fortail, Chactochloa lutescens and other grasses.

141. Pseudomonas petastits (Takimoto) comb. nov. (Bacterium petastits Takimoto, Ann. Phyt. Soc. Japan. 2, 1927, 55; Phytomonas petastits Magrou, in Haudurny et al. Diet d. Bact. Path., Paris, 1937, 393.) From M. L. Petastes, a generic name.

Rods. 0 8 to 1.1 by 1.1 to 1.7 microns. Motile with a polar flagellum. Gramnegative.

Gelatin. No liquefaction.

Beef agar colonies: White, circular or ameboid, butyrous.

Broth: Strong turbidity. Pellicle.

Milk: Coagulated in 30 days.

Nitrites produced from nitrates with gas formation.

Indole not produced. No II:S produced.

No evident acid in peptone broth but gas from glucose, lactose and sucrose. Acid but not gas from glycerol.

Weak growth in broth plus 6 percent salt.

Optimum temperature 27° to 30°C. Maximum 47°C. Minimum approximately 5°C.

Source: Isolated from brown to black lesions on Petasites japonicus in Japan. Habitat: Pathogenic on leaves of Petasites japonicus.

142. Pseudomonas liguicola Westerdijk and Buisman. (De Iepenziekte, Arnhem, 1929, 51.) From Latin, lignum, wood; -cola, dweller.

Rods: Single or short chains. Motile with 1 to several polar flagella. Gramnegative.

Gelatin: No liquefaction.

Malt agar streaks: Milk white with a colorless edge.

Broth: Turbid with light pellicle. Milk: No coagulation. No acid.

Nitrites not produced from nitrates.
Indole not formed.

Starch hydrolysis slight.

Optimum temperature ±25°C.

Source: From vessels of elm wood showing dark discoloration, in Holland. Habitat: Pathogenic in elm wood

143. Pseudomonas andropogoni (Erw. Smith) Stapp. (Bacterium andropogoni Erw. Smith, Bacteria in Relation to Plant Diseases, 2, 1911, 63; Elliott and Smith, Jour. Agr. Res, 38, 1929, 4; Stapp. in Sorauer, Handbuch der Pflanzenkrankheiten, 2, 5 Auf., 1928, 27; Phytomonas andropogoni Bergey et al, Manual, 376 ed., 1930, 276.) From M. Manual, 376 ed., 1930, 276.) From M.

L. Andropogon, a generic name (a synonym of Holcus).

Description from Elliott and Smith

(loc. cit.).

Rods: 064 by 1.76 microns Motile with one to several bipolar flagella Capsules, Gram-negative.

Gelatin. Feeble liquefaction or none Beef-extract agar colonies. Slow-growing, round, smooth, glistening, viscid,

white.

Broth: Growth slow with moderate turbidity in 48 hours A thin pellicle Milk: Alkaline and clears

Nitrites not produced from nitrates

Indole not formed. No H<sub>2</sub>S formed.

Not lipolytic (Starr and Burkholder,

Phytopath, 32, 1942, 601).

Acid but not gas from glucose, ambinose, fructose and vylose. No acid from sucrose, maltose, lartose, raffinose, glycerol and magnitol.

DIE ENG

Starch partially digested.
Optimum temperature 22° to 30°C
Maximum 37° to 38°C. Minimum 1 5°C
Optimum pH 60 to 66. Maximum
8.3 to 8.6. Minimum 50.

Source: Ellintt used for her description 4 cultures isolated from lesions on sorgo,

sorghum and broom-corn
Habitat. Pathogenic on sorghum, Holcus sorghum.

144. Pseudomonas woodsii (Smith) Stevens. (Bacterium woodsii Erw. Smith, Bact. in Relation to Plant Discases, 2, 1911, 62, Stevens, Plant Discase Tungi, New York, 1925, 39; Phytomonas woodsii Bergey et al., Manual, 3rd ed., 1930, 285.) Named for A. F. Woods, American plant pathologist.

Description from Burkholder and Guterman, Phytopath., 25, 1935, 118.

Rods: 0 67 by 1 56 microns. Motile with a polar flagellum. Gram-negative. Gelatin: No liquesaction.

Beef-extract ager slants Growth slow and scant, fillorm, creamy, butyrous. Broth: Turbid Milk: Becomes alkaline but otherwise little changed.

Nitrites not produced from nitrates. Indole not formed.

No H<sub>2</sub>S formed.

Not lipolytic (Starr and Burkholder, Phytopath, 52, 1912, 601). Acid but not gas from glucose, fruc-

Acid but not gas from glucose, fructose, galactose, arabinose, xylose; hamnose, lactose, glycerol and manuitol. Alfaline reaction from salts of acetic, citre, malle and succinic acids. Sucrose, maltose, salicin, and lactic and formic acids not fermented. Starch not hydrolyzed.

Slight growth in broth plus 3 per cent salt.

Aerobic.

Source: Isolated from water-soaked lesions on carnation leaves

Habitat: Pathogenic on carnation, Dianthus carvophullus.

145. Pseudomonas panici-miliacei (Ikata and Yamauchi) comb nov. (Bacterium pamei-miliacei Ikata and Yamauchi, Jour Plant Protect., 18, 1931, 35; Phylomonas panici-miliacei Burkholder, in Manual, 5th ed., 1939, 201) From M. L. Paneum miliaceum.

Description translated by Dr. K. Togashi

Rods: 0 8 to 1.1 by 1 8 to 2 6 microns Motile, with a single flagellum. Gramnegative.

Gelatin: Not liquefied.

Potato-agar plates Growth moderate, whitish, then tinged with light orange, undulating margins.

Broth. Turbid, white pellicle formed, Milk. No coagulation and slow digestion. Alkaline

Nitrates are produced from nitrates Indole not formed.

No II:S produced.

No seed and no gas from sucrose, glucose, lactose, glycerol and sodium nitrate.

Starch not hydrolyzed.

Optimum temperature 30° to 35°C

Facultativé anaerobe.

Source. Species first isolated from millet, Panicum miliaceum.

Habitat Causes a leaf stripe of Panicum miliaceum.

146 Pseudomonas saltciperda Lindeijer (Lindeijer, Inaug Diss, Univ. Amsterdam, 1932; Phytopath. Ztsehr., 6, 1933, 378, Bacterium saltciperda Burgwitz, Phytopathogenie Bacteria, Leningrad, 1935, 106; Phytomonas saltciperda Magrou, in Hauduroy et al., Dict. d. Bact Path, Paris, 1937, 408) From L. saltz (salters), willow; perdo, to destroy.

Rods 12 to 21 microns in length. Motile with a polar flagellum. Gramnegative

Gelatin. No liquefaction.

Beef wort agar colonies: Gray-white. Milk No acid nor coagulation.

Nitrites produced (small amount)

Indole formation slight.

No gas from carbohydrates.

Starch not hydrolyzed. Facultative anaerobe.

Source. Isolated from wilted branches of willow and pathogenicity proved Habitat Pathogenic on willow, Salix

Habitat · Pathogenic on spp.

147 Pseudomonas eriobotryae (Takımoto) Dowson (Bacterium eriobotryae Takımoto, Jour Plant Protect., 18, 1931, 354, Phylomonas eriobotryae Burkholder, in Manual, 5th ed., 1939, 205; Dowson, Trans Brit Mycol. Soc., 26, 1943, 10.)
From M L Eriobotrya, a generic name.

Translated by Dr. K. Togashi. Rods 07 to 09 by 22 to 3.0 microns

Motile, with 1 or 2 flagella Gramnegative.

Gelatin Not liquefied

Agar plates · Colonies appear after 3 days, white or hyaline, butyrous, margins entire.

Broth Moderately turbid, pellicle powdery, ring formed Milk: No coagulation, peptonized slowly. Alkaline

Nitrites not produced from nitrates.

Indole not formed.

No H2S produced.

No acid or gas from glucose, sucrose, lactose and glycerol in broth.

Starch not hydrolyzed.

Temperature relations: Minimum below 4°C, optimum 25° to 26°C, and maximum 32°C. Thermal death point 51°C.

Aerobic

Source: Species isolated from loquat, Eriobotrua naponica.

Habitat: Causes a bud rot of Eriobotrya japonica.

148. Pseudomonas wieringae (Elliott) comb nov. (Phytomonas betae Wieringa, Noderl. Trijdschr. Hyg, Microbiol. en Serol., Leiden, 2, 1927, 148; Bacterium wieringae Elliott, Man. Bact. Plant Pathogens, 1930, 204; Phytomonas wieringae Burkholder, in Manual, 5th ed, 1939, 206) Named for K. L. Wieringa, plant pathologist of Holland.

Because Bacterium betae Chester (Ann. Rept Del Col. Agr. Exp. Sta, 9, 1897, 53) may be a pseudomonad, the species name proposed by Elliott has been retained.

Description from Elliott (loc. cit.).
Rods: 0.5 to 20 microns. Motile with
1 to 5 polar flagella Gram-negative.

Beef-agar colonies: Smooth, round, white to gravish, fluorescent.

Milk: Cleared in 5 days Not coagulated.

Nitrites not produced from nitrates.

No gas from sugars.

Optimum temperature 28° to 30°C. Maximum 37°C. Minimum 4°C.

Source · Isolated from vascular rot of beets in Holland.

Habitat: Pathogenic on beets, Bela vulgaris,

Appendix I\*: The following species are believed to belong in the genus Pscudomonas although descriptions are frequently incomplete.

Achromobacter pollucidum Harrison. (Canadian Jour. Res , 1, 1929, 236.) Isolated from halibut. For a description of this species, see Bergey et al., Manual,

5th ed., 1939, 619.

Bacillus aurantiacus tingitanus Remlinger and Bailly. (Maroc Medical, No 150, 1935; See Lasseur, Dupaix and Babou, Trav. Lab. Microbiol. Fac. Pharm. Nancy, Fasc. 8, 1935, 41.) From water. Dissociates readily. Related to Pseudomonas fluorescens aureus Zimmermann. See p. 645.

Bacillus cyaneofluorescens Zangemeister. (Cent. f. Bakt., I Abt., 18, 1895, 321; Pseudomonas cyaneofluorescens Migula, Syst. d. Bakt., 2, 1900, 906) From blue

milk.

Bacillus fluorescens niralis Eisenberg (Eine Gletscherbakterie, Schmelck, Cent. f. Bakt., 4, 1888, 545; Eisenberg, Bakt. Diag, 3 Aufl., 1801, 77.) From the melting snow of a glacier. Probably a synonym of Pseudomonas fluorescens.

Bacillus lactes saponacei Weigmann and Zirn. (Cent. f. Bakt , 15, 1891, 468)

From soapy milk.

Bacterium auxinophilum Jacobs.
(Ann. Appl. Biol, 22, 1935, 619) A
Gram-negative organism with a polar
flagellum which liquefies gelatin rapidly.

Bacterium bosporum Kalninš. (Latvijas Universitätes Raksti, Serija I, No. 11, 1930, 259.) Decomposes cellulose, Single polar flacellum. From soil.

Bacterium briossi Payarino (Atti Ist. Bot. d. R. Univ. di Pavia, Ser 2, 18, 1910, 337.) The natural bost is Lyco-persicon exculentum. Payarino (Rev. di Patol. Veg., 6, 1913, 161) states that this organism and Phytobacter Iycopersicum Greenewge (Meded Rijks Hoogere Land, Tuin- en Boschbouwschool, Dell S, 6, 1912, 217) should be considered identi-

cal. It closely resembles Bacterium resicatorium Doidge (Jour. Dept. Agr. So. Africa, 1, 1920, 718) according to Gardner and Kendrick (Jour. Agr. Res., 21, 1921, 140).

Bacterium elaphorum Kalninš. (Latvijas Universitātes Ralsti, Serija I, No. 11, 1930, 257.) Decomposes cellulose Single polar flagellum. From soil.

Bactersumfraenkelis Hashimoto. (Zeit f Hyg, 51, 1899, 88.) A pleomorphic polar flagellate bacterium. From milk.

Bacterium gummis Comes, (Comes, Napoli, Maggio 18, 1854, 14; see Comes, Atti d. R. Ist. d'incoragiamento alli Sc., Ser. 3, 5, 1884, 4; Bacillus gummis Trevisan, I generi e le specie delle Batteriacee, Milano, 1889, 17.) Pathogenic on grance, Yilis spr.

Bacterium Irameriani Pavarino. (Atti R. Accad. Naz. Lincei Rend. Cl. Sci. Fis., Mat. et Nat., 20, 1911, 233.) Pathogenie on the orchid, Oncidium Irameriani.

Bactersum pusiolum Kalninš. (Latvijas Universitätes Raksti, Serija I, No 11, 1930, 261.) Decomposes cellulose. Single polar flagellum. From

manure.

Bacterium protozoides Kalninš. (Latvijas Ūniversitātes Raksti, Serija I, No. 11, 1930, 263) Decomposes cellu-

No. 11, 1930, 203 ) Decomposes centulose. Single polar flagellum. From soil. Pseudomonas acuta Migula (Culture No. 11, Lemble, Arch. f. Hyg, 29, 1897, 317; Migula, Syst. d. Bakt., 2, 1900, 921.)

From the intestine.

Pseudomonas alba Migula. (Bacillus funcerens albus Zimmermann, Bakt. unserer Trink- u. Nutzwässer, I Reihe, 1890, 18, Migula, Syst. d. Bakt., g. 1900, 909) From water. Bacillus fluorescens non liquefaciens Eisenberg, Bakt. Diag, 3 Aull., 1891, 145 may be identical according to Migula (loc. etc.).

Pseudomonas allii (Griffiths) Migula. (Bacterium allium Griffiths, Proc. Roy. Soc. Edinburgh, 51, 1887, 40; Migula,

Appendixes I and II prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1943.

Syst. d. Bakt., 2, 1900, 932) From rotted onions.

Pseudomonas aquatilis Migula. (Tataroff, Inaug. Diss., Dorpat, 1891, 31; Migula, Syst. d. Bakt., 2, 1900, 933.) From water. Said to form spores.

Pseudomonas aromatica Migula. (Bacillus crassus aromaticus Tatarofi, Inaug. Diss , Dorpat, 1891, 27; Migula, Syst. d. Bakt., 2, 1900, 880.) From water.

Pseudomonas aromatica var. quercitopyrogallica Kluyver, Hof and Boezaardt. (Enzymologia, 7 1939, 28.)

Pseudomonas articulata Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 462.) From the stomachs of birds.

Pseudomonas aucubicola Trapp. (Phytopath, 26, 1936, 264.) Isolated from Aucuba japonica Not pathogenic. Pseudomonas aurea Migula (Bazillus

fuorescens aureus Zimmermann, Bakt. funserer Trink- u. Nutzwässer, I Reihe, 1890, 14; Migula, Syst. d. Bakt., 2, 1900, 931.) From water.

Pseudomonas brassicae acidae Gruber (Cent f Bakt., II Abt., 22, 1909, 588). From sauerkraut Identical with Bacterium brassicae acidae Conrad (Arch. f Hyg., 29, 1897, 75) according to Lehmann and Neumann (Bakt Diag., 5 Aufl., 2 1912, 380)

Pseudomonas butyr: Migula. (Bacillus butyr: fluorescens Lafar, Arch. f Hyg, 15, 1891, 19; Migula, Syst. d. Bakt, 2, 1900, 894.) From butter.

Pseudomonas calciphila Molisch. (Cent. f Bakt, II Abt, 65, 1925, 136.) From fresh water. Deposits CaCO<sub>2</sub>.

Pseudomonas calco-acetica Clifton. (Enzymologia, 4, 1937, 246.)

Pseudomonas capsulata Migula. (Syst. d. Bakt , £, 1900, 915; not Pseudomonas capsulata Bergey et al., Manual, 1st ed., 1923, 124.) Similar to Pseudomonas macroselmis Migula.

Pseudomonas caryocyanea (Dupaix) Beijerinck. (Bacillus caryocyaneus Dupaix, Thesis, Univ. of Nancy, 1933, 1; Beijerinck, see Dupaix, ibid., 13; Bacterium caryocyaneum Dupaix, ibid., 246.) Isolated from rotten willow wood, from yeast mash and beer-wort. Name appears first as Bacillus carvocuancus on a culture sent by Beijerinck from Delft. Holland to the National Collection of Type Cultures, Lister Institute, London. Regarded by Dupaix as closely related to Bacillus cyanco-fluorescens Zangemeister (Cent. f. Bakt., I Abt., 18, 1895, 321: Pseudomonas cyaneo-fluorescens Migula, Syst. d. Bakt., 2, 1900, 906); Der blaue Bacillus, Mildenberg (Cent. f. Bakt., II Abt., 56, 1922, 309; Pseudomonas mildenbergii Bergey et al., Manual, 3rd ed., 1930, 172); and Bacillus pyocyaneus Gessard (Compt. rend. Acad. Sci. Paris. 94, 1882, 536).

Pseudomonas catarrhalis Chester. (Bacillus der Hundestaupe, Jess, Cent. f. Bakt., II Abt., 25, 1899, 541; Chester, Man. Determ. Bact., 1901, 308.) Isolated from catarrh in dogs.

Pseudomonas caviae Scherago. (Jour. Bact., 31, 1936, 83; Jour. Inf. Dis., 60, 1937, 215.) Cause of an epizootic septicemia in guinea pigs.

Pseudomonas chlorophaena Migula. (Syst. d. Bakt., 2, 1900, 899.)

Pseudomonas coccacea Migula. (Culture No. 10, Lembke, Arch. f. Hyg, 29, 1897, 317; Migula, Syst. d. Bakt., 2, 1900, 924.) From the intestine.

Pseudomonas cohaerea (sie) (Wright) Chester. (Bacillus cohaerens Wright, Mem. Nat. Acad. Sci., 7, 1895, 464; Chester, Man. Determ. Bact, 1901, 312.) From water.

Pseudomonas coli Migula. (Culture No. 8, Lembke, Arch. f. Hyg., 29, 1897, 315; Migula, Syst. d. Bakt., 2, 1900, 920) From the intestine.

Pseudomonas colloides Miguls. (Bacıllus fluorescens putidus colloides Tataroff, Inaug. Diss., Dorpat, 1891, 40; Migula, Syst. d. Bakt., 2, 1900, 902.) From water. Said to form spores.

Pseudomonas conradi Lehmann and Neumann. (Bakt. Diag., 5 Aufl., 2, 1912, 394.) Red pigment.

Pseudomonas delabens (Wright) Chester. (Bacillus delabens Wright. Mem. Nat. Acad. Sci., 7, 1895, 456, Chester, Man. Determ. Bact, 1901, 314.) From water.

Pseudomonas duplex Migula (Culture No. 7, Lembke, Arch. f. Hyg., 29, 1897, 314; Migula, Syst d. Bakt., 2, 1900, 922.) From the intestine.

Migula. Pseudomonas ellipsoidea (Bacillus oogenes fluorescens B. Zörkendörfer, Arch. f. Hyg., 16, 1803, 393; Migula, Syst. d. Bakt., 2, 1900, 925) From hens' eggs.

Pseudomonas ephemerocyanea Fuller and Norman. (Jour. Bact , 46, 1943, 274.) From soil. Decomposes cellulose.

Pseudomonas erythra Fuller and Norman. (Jour. Bact., 46, 1943, 276.) From soil. Decomposes cellulose.

Pseudomonas erythrospora (Cohn) Migula. (Bacillus erythrosporus Cohn, Beitr, z. Biol. d. Pflanzen, 3, Heft 1, 1879, 128; Migula, in Engler and Prantl, Die naütrl. Pflanzenfam., 1, 1a, 1895, 29 ) From air, meat infusion and water.

Said to form spores. Pseudomonas fimbriata (Wright) Chester. (Bacillus fimbriatus Wright, Mem. Nat. Acad. Sci., 7, 1895, 463, Chester, Man. Determ. Bact , 1901,

313 ) From water.

l'seudomonas fluorescens exiliosus van Hall. (Ztschr. f. Pflanzenkr., 13, 1903, 132.) Causes soft rot of shoots and builbs of iris (Iris app.).

Pseudomonas foliacea Chester (Bacillus fluorescens foliaceus Wright, Mem. Nat. Acad. Sci., 7, 1935, 439, Chester, Man. Determ. Ract , 1901, 321, Hacillus fluorescens-foliaceus Chester, ibid.) From water. Very similar to Pseudomonas incoanita Chester.

Pacudomonas casoformana Migula (Lin neuer grabildender Bacillus, Gartner, Cent. f. Bakt., 18, 1891, 1; Migula, Syst. d. Bakt., 2, 1900, 883 ) Gas bubbles in gelatin stab

Pseudomonas gracilis Migula, (Syst. d. Bakt., 2, 1900, 888.) Morphologically like Pseudomonas fluorescens Migula.

Pseudomonas granulata Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 464 ) From the stomach and intestine of birds.

Pseudomonas halestorgus Volcani. (Ph.D Thesis, Hebrew Univ., Jerusalem, 1910.) A halophilic pseudomonad from the Dead Sea.

Pseudomonas hydrosulfurca Migula. (Bacıllus oogenes hydrosulfureus B. Zorkendörfer, Arch f Hyg., 16, 1893, 385; Migula, Syst. d. Bakt., 2, 1900, 898.) From hens' eggs

Pseudomonas iridis van Hall. (Van Hall, Thesis, Univ Amsterdam, 1902 and Ztschr. f. Pflanzenkr., 13, 1903, 129; Bacterium iridis Elliott, Man. Bact. Plant Path., 1930, 142, Phytomonas tridis Magrou, in Hauduroy et al., Diet. d. Bact Path , Paris, 1937, 369.) Causes a rot of bulbs and leaves of iris (Iris spp.).

Pseudomonas 1118 (Frick) Migula. (Bacillus 1ris Frick, Arch. I. path. Anat., 116, 1889, 292; according to Eisenberg, Bakt, Diag. 3 Aufl., 1891, 148; Migula, Syst d Bakt., 2, 1900, 931.)

Pseudomonus statica (Fol and Chianella) Reinelt (Quoted from Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 367.) Phosphorescent.

Pseudomonas jaranica (Eijkmann) Migula (Photobacterium jaranense Tijdechr. Lukmann, Genecik Nederl -Indie, 31, 1892, 109; Abst. in Cent f Bakt , 12, 1892, 656, Bacillus saraniensia Dyar, Annala New York Acad Sci , 8, 1895, 359, Bacterium garamentis Chester, Man. Determ Bact . 1901, 170, Photobacterium jaranicum Lehmann and Neumann, Bakt Ding , 1 Auff . 2, 1896, 199, Migula, Syst d Bakt., 2, 1900, 953) From era fish in Java. Blue green luminescence,

Pseudomonas lactica Weses (Arle bakt. Inst, Karlsrube, 2, Helt 3, 1992, 238) From a veretable infusion

Preudomonas lana Fuller and Norman

(Jour. Bact., 46, 1943, 275.) From soil. Decomposes cellulose.

Pseudomonas lembkei Migula. (Culture No. 12, Lembke, Arch. f. Hyg., 29, 1897, 318; Migula, Syst. d. Bakt., 2, 1900, 896.) From the intestine.

Pseudomonas liquefaciens (Tataroff) Migula. (Bacillus liquefaciens Tataroff, Inaug. Diss., Dorpat, 1891, 29; Migula, Syst. d. Bakt., 2, 1900, 876.) From water.

Pseudomonas lister: Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 260.) From a vegetable infusion.

Pseudomonas longa Migula. (Bacillus fluorescens longus Zimmermann, Bakt. unserer Trink-u. Nutzwässer, I Reihe, 1890, 20; Migula, Syst. d. Bakt., 2, 1900, 907) From water.

Pseudomonas macroselmis Migula. (Bacıllus fluorescens putidus Tataroff, Inaug. Diss, Dorpat, 1891, 42; Migula, in Engler and Prantl, Die natürl. Pflanzenfam, 1, 1a, 1895, 29.) From water.

Pseudomonas maidis (Eisenberg) Migula. (Bacillus maidis Eisenberg, Bakt. Diag, 3 Aufl. 1891, 119; Migula, Syst. d. Bakt., 2, 1900, 877.) From corn grains soaked in water and from feces of pellagra patients.

Pseudomonas maschelii Migula. (Blaugrüner Bacillus, Maschek, Bakt. Untersuch, d. Leitmeritzer Trinkwasser, Jahresber. d. Oberrealschule zu Leitmeritz, 1887, Migula, Syst. d. Bakt. 2, 1900, 916.) From water.

Pseudomonas melochlora (Winkler and Schrötter) Migula (Bacillus melochloros Winkler and Schrötter, Ein neuer grünen Tarbstoff entwickelnder Bacillus, Wien, 1890; Migula, Syst. d Bakt., 2, 1900, 893) From caterpillar feces

Pseudomonas mesenterica Migula. (Bacillus fluorescens mesentericus Tataroff, Inaug. Diss, Dorpat, 1891, 38; Migula, Syst. d. Bakt., 2, 1900, 903.) From water

Pseudomonas metalloides Migula. (Bacillus rosaceus metalloides Tataroff, Inaug Diss., Dorpat, 1891, 65; not Bacterium rosaceus metalloides Dowdeswell, Ann. de Microgr., 1, 1888-89, 310, see

Heffernan, Cent. f. Bakt., II Abt., 8, 1902, 689; Pseudomonas rosacca Migula, 1902, 680; Pseudomonas rosacca Migula, in Engler and Prantl, 10: natürl. Pflanzenfam., 1, 1a, 1895, 29; Migula, Syst. d. Bakt., 2, 1900, 938.) Single flagellum. Red and yellow-red pigment. From water.

Pseudomonas minutissima Migula. (Bacillus fluorescens liquefacina minutissimus Unna and Tommasoli, Monatsh. f., prakt. Dermat., 8, 1889, 57, according to Eisenberg, Bakt. Diag., 3 Aufl., 1891, 76; Migula, Syst. d. Bakt., 2, 1900, 891.) Found on human skin in cases of seborrhoic externa.

Pseudomonas mobilis Migula. (Culture No. 9, Lembke, Arch. f. Hyg., 29, 1897, 316; Migula, Syst. d. Bakt., 2, 1990, 923.) From the intestine.

Pseudomonas monadiformis (Kruse) Chester. (Bacillus coli mobilis Messca, Riv. d'Igiene, Rome, 1890; Bacillus monadiformis Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 374; Chester, Man. Determ. Bact., 1901, 303.) From tynhoid stools.

Pseudomonas mucidolens Levine and Anderson. (Jour. Bact., 23, 1932, 337.) Causes musty odors in eggs. Also milk (Olsen and Hammer, Iowa State Coll. Jour. Sci., 9, 1934, 125).

Pseudomonas mucidolens var. tarda Levine and Anderson. (Jour. Bact., 25, 1932, 337.) Causes musty odors in egss-Pseudomonas nexibilis (Wright) Chester. (Bacillus nexibilis Wight) Mem. Nat. Acad. Sci., 7, 1895, 441; Chester, Man. Determ. Bact., 1901, 309.) From water.

Pseudomonas nivalis Szilvinyi. (Cent. f. Bakt., II Abt., 94, 1936, 216.) A red chromogen isolated from red snow in Austria.

Pseudomonas ochroleuca Miguls. (Bacillus 7, Zörkendörfer, Arch. f. Hyg., 16, 1893, 396; Migula, Syst. d. Bakt., 2, 1900, 897.) From hens' eggs.

Pseudomonas cogenes Migula. (Bacillus cogenes hydrosulfureus & Zörkendörfer, Arch. f. Hyg., 16, 1893, 386; Migula, Syst. d. Bakt., 2, 1900, 878.) Single flagellum. From hens' eggs.

Pseudomonas ovi Migula. (Bacillus oogenes "
f. Hyg..

Bakt., ź

Pseudomonas ovicola Migula. (Bacillus oogenes fluorescens γ, Zörkendörfer, Arch. f. Hyg., 16, 1893, 394; Migula, Syst. d. Bact., 2, 1900, 925.) From hens' eves.

Pseudomonas pallescens Migula. (Bacillus viridis pallescens Frick, in Virchow, Arch. I. path. Anat., 116, 1859, 292; according to Eisenberg, Bakt Dieg, 3 Aufl., 1891, 154; Migula, Syst. d. Bakt., 2, 1990, 297.) Source not given

Pseudomonas pansinii Migula (Bacillus fluorescens non liquefaciens Pansini, in Virchow, Arch. f. path Anat, 122, 1890, 452; Migula, Syst d. Bakt., 2,

1900, 926.)

Pseudomonas pelliculosa Migula. (Bacillus oogenes fluorescens & Zörkendörfer, Arch. f. Hyg., 16, 1893, 395; Migula, Syst. d. Bakt., 2, 1900, 926 ) From hens' eggs.

Pseudomonas pellucida Kern (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 465.) From the intestine of birds

Pseudomonas plehniae Spieckermann and Thienemann. (Arch f. Hyg, 74, 1911, 110.) Isolated from carp Pathogenic for many species of fish.

Pesudomonas plicata (Frankland and Frankland) Migula. (Bacillus plicatus Frankland and Frankland, Phil. Trans Roy Soc. London, 178, B, 1887, 273; Migula, Syst. d. Bakt., 2, 1900, 881.) From sir.

Pseudomonas pseudotyphosa Migula. (Typhusähnlicher Bacillus, Lustig, Diag. d. Bakt. d. Wassers, 1893, 16; Migula, Syst. d. Bakt., 2, 1900, 893.) From water.

Pseudomonas pullulans (Wright) Chester. (Bacillus pullulans Wright, Mem. Nat. Acad. Sci. 7, 1894, 415; Chester, Man Determ. Bact., 1901, 315) From water. Pseudomonas protea Frost. (U. S. Public Health Ser., Hyg. Lab. Bull. 66, 1910, 27.) From filtered river water. Can be agglutinated by specific typhoid immune-serum.

Pseudomonas rosea Chester. (Bacıllus roseus vini Bordas, Joulin and Rackowski, Compt. rend. Acad. Sci. Paris, 126, 1838, 1850; Chester, Man. Determ Bact., 1901, 327; not Pseudomonas rosea Migula, in Engler and Frantl, Die natüri. Pflanzenfam., 1, 1a, 1805, 30.) From wine. Said to form spores.

Pseudomonas (Hydrogenomonas) saccharophila Doudoroff. (Enzymologia, 9, 1940, 50.) From stagnant water.

Pesudomonas sapolactica (Eichholz) De Rossi. (Bacterium sapolacticum Eichholz, Cent. f. Bakt., II Abt., 9, 1902, 631, De Rossi, Microbiologia Agraria e Technica, Torino, 1927, 693.) Isolated from soapy milk.

Pseudomonas sericea Migula. (Seidenglänzender Bacillus, Tataroff, Inaug. Diss, Dorpat, 1891, 26; Migula, Syst d. Bakt., 2, 1900, 882.)

Pseudomonas tenuis Migula. (Bactllus fluorescens tenuis Zimmermann, Bakt. unserer Trink- u. Nutzwässer, I Reihe, 1800, 16, Migula, Syst d. Bakt., 2, 1900, 910.) From water.

Pseudomonas trommelschlägel (Ravenel) Chester. (Bacillus trommelschlägel Ravenel, Mem. Nat. Acad. Sci. 8, 1806, 26; Chester, Man Determ Bact., 1901, 327.) From soil. Said to form spores.

Pseudomonas undulata Chester. (Bacillus fluorescens undulatus Ravenel, Mem Nat. Acad. Sci., 8, 1896, 20; Chester, Man. Determ. Bact., 1901, 323 ) Trom soil Said to form spores

Pseudorionas rirescens (Frick) Migula (Bacillus virescens Frick, Arch. f path. Anat., 116, 1889, 292; Migula, Syst. d. Bakt., f, 1900, 916) From green sputum.

Pseudononas riridans (Symmers) Migula (Bacillus riridans Symmers, Brit. Med. Jour., No. 1615, 1891, 1222; Abst in Cent. f. Bakt., 12, 1892, 165; Migula, Syst. d. Bakt., 2, 1900, 800.) From water. Pseudomonas viridescens Chester. (Bacillus viridescens liquefaciens Ravenel, Mem Nat. Acad. Sci., 8, 1896, 24; Chester, Man. Determ. Bact., 1901, 328.) From soil. Said to form spores.

Pseudomonas riridis Migula. (Bacillis der grunen Diarrhoe der Kinder, Lesage, Arch. d. Physiol norm. et path., 20, 1883, 212, see Eisenberg, Bakt. Diag., 3 Aufl., 1891, 238, Migula, Syst. d. Bakt., 2, 1900, 886 ). From intestine of children.

Pseudomonas weigmanni Migula. (Bakterie IV, Weigmann and Zirn, Cent. f. Bakt, 15, 1894, 466; Migula, Syst. d. Bakt, 2, 1900, 892) From soapy milk.

Pseudomonas zörkendörferi Migula. (Bacıllus oogenes fluorescens a, Zörkendorfer, Arch f Hyg, 18, 1893, 392; Migula, Syst. d Bakt, 2, 1900, 897.) From hens' eggs.

Appendix II: The following polar flagellate organism has been described from activated studge II. Winogradsky has also described polar flagellate forms from the same source that form zoogleea. (Compt. rend. Acad Sci. Paris, 200, 1935, 1887; Ann. Inst. Pasteur, 58, 1937, 333).

Zoogloea ramilgera Kruse emend. Butterfield. (Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 1, 1896, 68; Butterfield, Public Health Reports, 59, 1935, 671; Culture No. 50, Wattie, Pub Health Reports, 57, 1942, 1519.)

Rods: 1 by 2 to 4 microns, with rounded ends. Non-spore-forming. Capsules present. Motile with a single long polar flagellum. Gram-negative.

Gelatin: No liquefaction.

Grows better in aerated liquid media.

Agar: Scant growth.

Agar: Scant growth Indole not formed.

No HaS produced.

No acid or gas from carbohydrates. Nitrites not produced from nitrates.

Optimum pH 7.0 to 7.4.

Optimum temperature 28° to 30°C. Good growth at 20° and at 37°C. Minimum temperature 4°C.

Strict aerobe.

Distinctive character .Oxidizes sowage. Source · Isolated from activated sludge. Habitat : Produces zooglocal masses in activated sludge.

## Genus II. Xanthomonas Dowson\*

(Phytomonas Bergey et al., Manual, 1st ed., 1923, 174; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 187)

Cells usually monotrichous, with yellow, water-insoluble pigment. Proteins are usually readily digested. Milk usually becomes alkaline. Hydrogen sulfide is produced. Asparagin is not sufficient as an only source of carbon and nitrogen. Acid is produced from mono- and disaccharides. Mostly plant pathogens causing necrosis From Gr. zanthus, yellow; monas, a unit; M. L. monad.

The type species is Xanthomonas hyacinthi (Wakker) Dowson.

Key to the species of genus Xanthomonas.

- 1. Colonies yellow.
  - a Gelatin liquefied.
    - b. Starch hydrolysis feeble.
      - c. Nitrites not produced from nitrates.
        - Xanthomonas hyacinthi.
          - 2. Xanthamonas pruni.
          - 3. Xanthomonas vilians.

Prepared by Prof. Walter H. Burkholder, Cornell Univ., Ithaca, N. Y., June, 1943.

- ec. Nitrites produced from nitrates.
  - Xanthomonas beticola.
    - 5. Xanthomonas lactucae-scariolae.
      - Xanthomonas rubrilineans
- bb. Starch hydrolysis strong
- c. Nitrites not produced from nitrates. d No brown pigment in beef-extract agar.
  - Xanthomonas barbareae.
  - Xanthomonas begoniae. 8
  - 9a Nanthomonas campestris var. armoraciae Xanthomonas campestris.

  - 10. Xanthomonas citri.
  - Xanthomonas corylina. 11
  - Xanthomonas eucurbitae. 13 Xanthomonas dieffenbachiae.
  - Xanthomonas holeicola.
  - Xanthomonas incanae. 14
  - Xanthomonas juglandis. 15
  - Xanthomonas lespedezae. 16
  - 18 Xanthomonas malracearum.
    - Xanthomonas pelargonii.
  - Xanthomonas phascoli. 19
  - 20a Xanthomonas phascols var. sojense 20
  - 21. Xanthomonas plantaginis.

  - Xanthomonas recinicola 23a Nanthomonas translucens t sp hordes
  - 23b Xanthomonas translucens f sp undulosa.
  - 23c Xanthomonas translucens i sp secalis. 23d Nanthomonas translucens [ sp horder-arenae 23e Xahthomonas translucens f sp cerealis

    - 21 Xanthomonas rasculorum
      - Xanthomonas resiculoria
  - 25a Xanthomonas resicutoria var raphani dd Brown pigment produced in beef-extract media.
    - 26 Xanthomonas nalatae
      - 20b Nanthomonas phascoli var fuscans
  - ce. Nitrites produced from nitrates 27 Xanthomonas papatericola
  - ecc. Ammonia formed in nitrate media
    - 28 Xanthomonas alfalfar

  - bbb. Starch not hydrolyzed e Nitrates produced from natrates Xaniformanas acernae
    - ce Nitrates not produced from nitrates
      - 39 Xanibamanas carolac
        - 31. Nantharonas le brae 32 Nanthoronas prormicola
    - 23 Xanthamange resteativia ecc Ammoria formed in natrate media
      - 31. Xanilamanas peransi

bbbb. Starch hydrolysis not reported.

e Nitrites produced from nitrates.

34. Xanthomonas antirrhini.

35. Xanthomonas heterocea.

cc. Nitrites not produced from nitrates.

36. Xanthomonas aummisudans.

37. Xanthomonas lactucae.

38. Xanthomonas nigromaculans.

az. Gelatin not liquefied.

b. Starch not hydrolyzed.

39. Xanthomonas oruzae.

asa. Gelatin not reported.

b. Starch hydrolyzed.

40. Xanthomonas celebensis.

2. Colonies whitish to cream.

a. Gelatin liquefied.

Starch hydrolyzed.

c. Nitrites produced from nitrates.

41. Xanthomonas panici.

42. Xanthomonas proteomaculans.

43. Xanthomonas manihotis.

ec. Nitrites not reported.

44. Xanthomonas rubrisubalbicans.

bb. Starch not reported.

Xanthomonas cannae.

46. Xanthomonas zingiberi.

47 Xanthomonas conjaci.

 Xanthomonas hyacinthi (Wakker) Dowson. (Bacterium hyacinthi Wakker. Botan. Centralblatt, 14, 1883, 315; Bacillus hyacınthı Trevisan, I generi e le specie delle Batteriacce, 1889; 19: Pseudomonas huacinthi Erw Smith, Bot, Gazette, 24, 1897, 188; Phytomonas hyacinthi Bergey et al., Manual, 1st ed., 1923, 177; Dowson, Cent. f. Bakt., II Abt , 100, 1939, 188.) From Gr. hvacinthus, the hyacinth; M. L Hyacinthus, a generic name.

Description from Smith, Div. Veg. Phys and Path., U S. D. A. Bul. 26, 1901, 40,

Rods · 0.4 to 0 6 by 0 8 to 2 microns. Motile with a polar flagellum. Filaments

present. Gram-negative. Gelatin · Slow liquefaction.

Agar colonies Circular, flat, moist, shining, bright yellow. Media stained brown.

Milk: Casein is precipitated and digested. Tyrosine crystals produced. Nitrites not produced from nitrates Indole: Slight production. Hydrogen sulfide is produced.

Acid, no gas, from glucose, fructose, galactose, sucrose and maltose.

Starch: Hydrolysis slight.

Optimum temperature 28° to 30°C. Maximum 34° to 35°C. Minimum 4°C. Aerobic, with the exception of maltose, where it is facultative anaerobic.

Habitat: Produces a yellow rot of hyacinth bulbs, Hyacinthus orientalis.

2. Xanthomonas pruni (Erw. Smith) Dowson. (Pseudomonas pruni Erw. Smith, Science, N. S. 17, 1903, 456; Bacterium pruni Erw. Smith, Bacteria in Relation to Plant Dis., 1, 1905, 171; Bacillus pruni Holland, Jour. Bact., 5, 1920, 220; Phylomonas pruni Bergey et

al., Manual, 1st ed., 1923, 179; Dowson, Cent. f. Bakt., 11 Abt., 199, 1939, 199) From L. prunus, plum; M. L. Prunus, a generic name.

Probable synonym · Phytomonas cerass wraggi Sackett, Col. Agr. Exp. Sta. Rept., 58, 1925, 17; Pseudomonas cerass uraggi, bidd.; Bacterium cerasi wraggi. Elliott, Bact. Plant Pathorens. 1930. 111.

Description from Dunegan, U S Dept Agr., Tech. Bull. 273, 1932, 23

Rods: 0 2 to 0 4 by 0 8 to 1 0 microns Capsules. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefaction

Beef-extract agar colonies Yellow, circular, smooth, convex, edges entire Broth: Turbid becoming viscid

Milk: Precipitation of casem and digestion.

Nitrites not produced from nitrates Indole not formed

Hydrogen sulfide not produced

drogen sulfide produced (Burkholder) Lipolytic (Starr and Burkholder, Phytopath . 52, 1942, 600)

Acid from arabinese, xylose, glucose, fructose, galactose, mannose, maltose, lactose, sucrose, raffinose, melezitose

Starch is hydrolyzed (slight)
Aerobic.

Aerobic.

Optimum temperature 21° to 29°C Maximum 37°C.

Source: Smith isolated the pathogen from Japanese plums.

Habitat: Pathogenic on plum (Prunus salicina), peach (P persica), apricot (P. armenicca), etc

 Xanthomonas vittans (Brown) Start and Weiss (Bacterium ritians Brown, Jour. Agr. Res., 15, 1918, 379, Phytomonas ritians Bergey et al., Manual, 1st ed. 1923, 183; Pecudomonas exitans Stapp, in Sorauer, Handb. d. Pfanzenkrahl, 2, 5 Aufl., 1928, 287; Start and Weisv, Phytopath, 33, 1913, 316 ) From Latin, ritians, injuring, infecture.

Rods: Motile with bipolar flagella. Gram-negative Gelstin: Slow liquefaction.

Beef-extract agar colonies: Circular, smooth, thin, cream to cream-yellow. Broth: Turbid with yellow ring.

Broth: Turind with yellow ring, Milk: Clears and turns alkaline. Nitrites not produced from nitrates. Indoie: Feeble production.

Hydrogen sulfide: Peeble production. Acid but not gas from glucose. Starch: Feeble hydrolysis.

Starch: Feeble hydrolysis.

Optimum temperature 26° to 25°C.

Maximum 35°C. Minimum 6°C.

Acrobic.
Source: Isolated from the stem of
discased lettuce plants from South
Carolina

Habitat: Pathogenic on lettuce, Lac-

 Xasthomons beticola (Smith, Brown and Townsend) comb. nor (Bacterium beticolum Smith, Brown and Townsend, U. S. Dept. Agr., Bur. Plant Ind., Bul. 123, 1911, 191; Pseudomons beticola Holland, Jour. Bact., 8, 1920, 221; Phytomonas beticola Bergey et al., Vanual, 1st ed., 1923, 182) From Latin, beta, beet., ecol., diveller.

Description from Brown, Jour Agr. Res., 57, 1928, 167, where the species is referred to as Bactersum betteola (Smith, Brown and Townsend) Potebnia

Rods 04 to 08 by 06 to 20 microns Motile with 1 to 4 polar flagella Capsules Gram-visible

Gelatin . Liquelaction.

Beef-agar siants Moderate fillform growth, flat, glistening, yellow.

Broth: Turbid, yellow ring, abundant sediment.

Milk Congulation and peptonization, Indole not formed,

Hydrogen sulfide formed.

Nitrites produced from nitrates.

Acid from glucose, sucrose, maltose, mannitol. No seid from lactose.

Starch hydrolysis feeble,

Optimum temperature 23°C, Maximum 39°C. Minimum 1.5°C. Optimum pH 65. Maximum 9.0 to 9.5. Minimum 4.5 to 48.

Tolerates salt up to 9 per cent.

Aerobic.

Source: Isolated from galls on sugar beets collected in Colorado, Kansas, and Virginia.

Habitat: Produces cell on sugar backs

Habitat: Produces gall on sugar beets and on garden beets.

Note: It is doubtful whether this species belongs in this genus

 Xanthomonas lactucae-scariolae (Thornberry and Anderson) comb. nov. (Phylomonas lactucae-scariolae Thornberry and Anderson, Phytopath., 27, 1937, 109.) From Lactuca scariola, the host.

Rods 0 5 to 1 0 by 1.0 to 1.5 microns. Motile with 1 or 2 polar flagella. Chains present. Capsules Gram-negative.

Gelatin Slow liquefaction

Glucose agar colonies Round, entire, finely granular, amber vellow.

Broth. Turbid. No pellicle. A yellow rim.

Milk: Slight acid, and peptonization Nitrites are produced from nitrates. Hydrogen sulfide not formed.

No gas from carbon sources.

Starch: Slight diastatic activity.
Optimum temperature 25°C. Maximum 35°C Minimum 7°C

Aerobic.

Source Isolated from necrotic lesions on wild lettuce.

Habitat. Pathogenic on wild lettuce, Lactuca scariola, but not on cultivated lettuce, Lactuca sativa.

6. Xanthomonas rubrilineans (Lee et al.) Starr and Burkholder. (Phylomonas rubrilineans Lee, Purdy, Barnum and Martin, Hawanian Sugar Planters' Assoc. Bull., 1925, 25; Pseudomonas rubrilineans Stapp, in Sorauer, Handb. d. Pflanzenkrank, 2, 5 Aufl, 1928, 35; Bacterum rubrilineans Elhott, Man. Bact. Plant Path, 1930, 195; Starr and Burkholder, Phytopath., 32, 1942, 600.) From Lruber, red; lineans, striping

Rods: 0.7 by 1.67 microns. Motile with 1 or seldom more polar flagella Gram-negative.

Gelatin: Liquefaction.

Agar (Beef-extract + glucose) colonies: Small, smooth, glistening, buff to yellow.

Broth: Turbid with pellicle. Sedinent.

Milk: Casein precipitated and digested. Nitrites are produced from nitrates Indole not produced.

Hydrogen sulfide not formed.

Not lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 600).

Acid from glucose, fructose, arabinose, xylose, lactose, sucrose, raffinose and mannitol.

Starch: Slight hydrolysis.

Growth range, pH 5 4 to pH 7.3. Facultative anaerobe.

Source: Description from 3 cultures isolated from the red stripe lesions in sugar cane.

Habitat: Pathogenic on sugar cane.

 Xanthomonas barbareae Burkholdei. (Burkholder, Phytopath., 51, 1941, 348-Phytomonas barbareae Burkholder, tbid.)
 From M. L. Barbarea, a generic name. Rods; 0.4 to 0.95 by 1 0 to 3.15 microus. Motile with a single polar flagellum Gram-negative.

Gelatin: Liquefaction.

Beef-extract peptone colonies: Circular, yellow, smooth, butyrous, growth moderate.

Potato glucose agar: Growth abundant, pale vellow. Mucoid.

Broth: Turbid, yellow granular ring-Milk: Soft curd, with clearing and production of tyrosine crystals Litmus reduced

Nitrates utilized but no nitrites formed.

Asparagine and nitrites not utilized.

Hydrogen sulfide produced.

Indole not formed.

Lipolytic (Starr and Burkholder, loc. cit.).

Acid from glucose, galactose, xylose, maltose, sucrose, and glycerol. Alkali

produced from salts of malonic, citric, malic, and succinic acids. Rhamnose, salicin and hippuric acid salts not utilized.

Starch hydrolyzed. Aerobic.

Distinctive characters Similar to Xanthomonas campestris but does not infect cabbage, cauliflower or horseradish

Source: From black rot of winter cress, Barbarea vulgaris.

Habitat: Pathogenie on leaves and stems of Barbarea vulgaris

Xanthomonas begoniae (Takimoto) Dowson. (Bacterium begoniae Takimoto. Jour. Plant. Protect , 21, 1934, 262, Pseudomonas begoniae Stapp, Arbeiten Biol. Reichsanst f Land- und Forstn , 22, 1938, 392; Phytomonas begoniae Burkholder, in Manual, 5th ed., 1939, 162, Dowson, Cent. f Bakt . II Abt . 100. 1939, 190.) From M. L. Begonia, a generic name

Probable synonyms: Bacterium begoniae Buchwald nom nud, Gartner-Tidende, 45, 1933, 1; Phytomonas flata begonige Wieringa, Tidschr Plantzickt, 41, 1935, 312; Bacterium flavozonala McCulloch, Jour. Agr Res , 54, 1937, 859 (Xanthomonas flarozonatum Dowson, loc cit ).

Translated by Dr K. Togashi

Rods: 05 to 06 by 12 to 20 microns Motile with a polar flagellum negative.

Liquelae-Gelatin: No liquefaction tion (Wieringa, loc cit, McCulloch, loc. est., Dowson, loc est, and Stapp, loc. cit.).

Potato agar colonies Circular, convex, smooth, moist, shining, vellow

Broth: Turbid. Yellow pelitele and precipitation.

Milk; No congulation. Casein digested Alksline

Nitrites not produced from nitrates

Indole not produced Hydrogen sulfide produced

Lipolytic (Starr and Burkholder, Phy topath., 52, 1942, 600)

Starch hydrolyzed (Dowson, Jour. Roy. Hort Soc , 63, 1938, 289)

No acid orgas in peptone broth from glucose, aucrose, lactose or glycerol Acid from glucose, sucrose, lactose, mannitol and glycerol in peptone-free medium (McCulloch, loc, cit ).

Optimum temperature 27°C, Maximum 37°C. Minimum 1° to 3°C. Isolated from leaf spot of Source

beconia.

Habitat Pathogenic on Begonia spp.

Xanthomonas campestris (Pammel) Dowson. (Bacillus campestris Pammel, Iowa Agr. Exp. Sta Bull 27, 1895, 130, Pseudomonas campestris Erw. Smith, Cent. f Bakt., II Abt , 5, 1897, 284, Bacterium campestris (sic) Chester, Del Col Agr Exp Sta Ann Rept , 9, 1897, 110, Phytomonas campestris Bergey et al , Manual, 1st ed , 1923, 176, Donson, Cent f Bakt, H Abt. 100, 1939, 190 ) From L. campestris of the field

Description from McCulloch (Jour. Agr. Res , 58, 1929, 278) Species is probably composed of several varieties. See descriptions by Mckta, Ann Appl. Biol , 12, 1925, 330, Paine and Nirula, Ann Appl Biol , 15, 1928, 46, Wormald and Frampton, Ann Rept Last Mall Res Sta , 1926 and 1927, H Supplement, 1928, 108, and others

Rods 03 to 05 by 0.7 to 20 microns Motile with a polar flagellum Capsules. Gram-negative.

Gelstin Liquefied

Heef agar colonies Wax yellow, round, smooth, shining, translucent, margins entire

Turbid with sellow rim and Reath sometimes a pellicle

Milk Casein digested with the formation of tyrosine crystals. Alkaline

Natrates not produced from natrates

Indole formation weak

Hydrogen sulfide produced

Lapolytic (Starr and Burkholder, Phytopath , \$2, 1942, 600)

Acid, no gas, from glucose, surmer, isctose, gipremi and mannetel.

Starch is hydrolyzed.

Optimum temperature 28° to 30°C. Maximum 36°C.

Aerobic

Distinctive characters: Causes a vascular infection in cabbage, cauliflower and rutabagas.

Source: Pammel (loc. cit.) first isolated the pathogen from diseased rutabagas.

Habitat: Pathogenic on cabbage, cauliflower and other related species.

9a. Xanthomonas campestris var. armoraciae (McCulloch) Burkholder. (Racterium campestre var. armoraciae McCulloch, Jour. Agr. Res. 58, 1929, 260; Phytomonas campestris var. armoraciae Bergey et al., Manual, 37d ed., 1930, 251; Burkholder, Phytopath., 52, 1942, 601) From Gr. Armoracia, the horse radish.

Cultural characters same as Xanthomonas campestris.

Distinctive characters: Causes a leaf spot of horse radish. No vascular infection.

Source: Isolated from discased horseradish leaves collected in Washington, D. C., Virginia, Connecticut, Iowa and Missouri.

Habitat: Pathogenic on horse radish and related species.

10 Kanthomonas citri (Hasse) Dowson (Pseudomonas citri Hasse, Jour. Agr. Res., 4, 1915, 97; Bacterium citri Doidge, Union So. Africa, Dept Agr. Sci Bul. 8, 1916, 20; Bacillus citri Holland, Jour. Bact., 5, 1920, 218; Phylomonas citri Bergey et al., Manual, 1st ed., 1923, 181; Dowson, Cent. f. Bakt., II Abt., 100, 1933, 190.) From M. L. Citrus, a generic name.

Rods: 0 5 to 0 75 by 1.5 to 2 microns, occurring in chains. Motile with a single polar flagellum. Gram-negative.

Gelatin Liquefied.

Beef agar colonics: Appear in 36-48 hours, circular, smooth, raised, dull yellow.

Broth: Turbid in 24 hours. A yellow ring formed.

Milk: Casein is precipitated,

Nitrites not produced from nitrates.

Hydrogen sulfide produced (Reid, New Zcaland Jour. Sci. and Tech., 22, 1938, 60). Indole not formed.

No gas from glucose, lactose or mannitol.

Starch hydrolyzed (Reid, loc. cit.). Aerobic.

Optimum temperature, 25° to 34°C. Maximum 38°C. Minimum 10°C. (Okabe, Jour. Soc. Trop. Agr., 4, 1932, 476).

Source: Isolated from canker on orange. Habitat: Produces a canker on many species of Citrus and related plants.

11. Xanthomonas corylina Miller, Bollen, Simmons, Gross, and Barss. (Miller et al., Phytopath., 99, 1940, 731; Phytomonas corylina Miller et al., tbid.) From Gr. corylus, the hazelnut; M. L. corylina, of the hazel nut.

Rods: 0 5 to 0.7 by 1.1 to 3.8 microns Motile with a polar flagellum. Capsules Gram-perative.

Gelatin : Liquefaction.

Nutrient glucose-agar streaks: Abundant growth, filiform, convex, glistening, smooth, opaque, pale lemon yellow, viscid.

Broth: Turbid. Ring formed in 2-5 days.

Milk: Enzymatic curd that is slowly digested. Litmus reduced. Crystal formation (Burkholder).

Nitrites not produced from nitrates.

Nitrices not produced from nitrates.

Nitrogen sources utilized are peptone, aspartic acid, alanine, leucine, sodium ammonium phosphate, allantoin, tyrosine, uric acid and brucine.

Indole is not produced.

Hydrogen sulfide not produced on lead acetate agar. H<sub>2</sub>S produced after Zobell and Feltham's method (Burkholder).

Selenium dioxide reduced.

Lipolytic (Starr and Burkholder, Phytopath., 52, 1942, 600).

Acid, no gas from glucose, fructose, galactose, lactose, sucrose, maltose, xy-lose, raffinose, mannitol, glycerol, and starch. Alkali from salts of citric lactic,

malie and succinic acids. Arabinose, rhamnose, dulcitol, salicin, inulin, and cellulose not utilized.

Starch is hydrolyzed.

Optimum temperature 28° to 32°C. Maximum 37°C. Minimum 5° to 7°C. Thermal death point 53° to 55°C.

pH range for growth. pH 5 2 to 10 5. Optimum pH 6 to 8.

Strict aerobe.

Distinctive characters: Cultural characters the same or similar to Xanthomonas juglandis. The two species do not cross-infect.

Source: 26 isolates from widely scattered filbert orchards in Oregon and Washington.

Habitat: Pathogenic on filberts (Corylus avellana and C. maxima).

12 Xanthomonas cucurbitae (Bryan) Dowson, (Bacterium cucurbitae Bryan, Science, 63, 1926, 165, Bryan, Jour Agr. Res., 40, 1930, 389; Phytomonas cucurbitae Bergey et al., Manual, 3rd ed, 1930, 251; Pseudomonas cucurbitae Stapp, Bot. Rev., 1, 1935, 408; Dowson, Cent. f. Bakt , II Abt., 100, 1939, 190.) From L curcurbita, a gourd, M. L. Cucurbita, a generic name.

Rods: 0.45 to 0.6 by 0.5 to 1.3 microns Motile, usually with a single polar flagellum. Gram-negative.

Gelatin: Liquefied.

Beef-agar slants: Growth moderate, mustard yellow, undulating margins, viscid to butyrous.

Broth: Moderately turbid Ring and yellow sediment.

Milk: Precipitation of casein and digestion. Alkaline.

Nitrites not produced from nitrates Indole not formed.

Hydrogen sulfide produced

Acid from glucose, galactose, fructose, lactose, maltose, sucrose and glycerol. No acid from mannitol Starch is hydrolyzed.

Optimum temperature 25° to 30°C. Maximum 35°C.

Optimum pH 65 to 70. Limits of growth pH 58 to 90.

Slight growth in 5 per cent salt.

Source: Species first isolated from

squash. Habitat: Causes a leaf spot of squash and related plants.

13. Xanthomonas dieffenbachiae (Mc-Culloch and Pirone) Dowson, (Phytomonas dieffenbachiae McCulloch and Pirone, Phytopath , 29, 1939, 962; Bacterium dieffenbachiae McCulloch and Pirone, tbid.; Dowson, Trans. Brit. Mycel. Soc., 26, 1943, 12.) From M. L. Dieffenbachia, a generic name.

Rods 0 3 to 0 4 by 1.0 to 1 5 microns. Motile with a single polar flagellum. Capsules. Gram-negative.

Gelatin: Liquefied.

Beef-infusion peptone agar colonies: Slow growing, circular, flat, smooth, translucent. Butyrous, Massicot to Naples vellow. Broth, Turbid. Yellow rim or slight

pellicle. Milk: Slow pentonization and forma-

tion of tyrosine crystals. Litmus re-

Nitrites not formed from nitrates Indole not produced.

Hydrogen sulfide produced

Acid from glucose, sucrose, lactose, galactose, fructose and glycerol Growth but no acid in maltose and mannitol. Starch moderately hydrolyzed.

Optimum temperature 30° to 31°C. Maximum 37° to 38°C. Minimum 5°C. Aerobe.

Source: Seven isolates from diseased leaves of Dieffenbachia picta.

Habitat: Pathogenic on Dieffenbachia picta. Artificial infection of Dracaena fragrans.

14. Xanthomonas holcicola (Elliott) Starr and Burkholder. (Bactersum holcicola Elliott, Jour. Agr. Res., 40, 1930, 972; Phytomonas holcicola Bergey et al., Manual, 4th ed., 1934, 271; Pseudomonas

Optimum temperature 25° to 30°C. Maximum 36° to 38°C. (Elliott, loc. cit.). Source: Isolated from angular leaf spot

of cotton.

Habitat: Pathogenic on cotton whereever it is grown, causing a leaf spot, a stem lesion and a boll lesion.

19. Xanthomonas pelargonii (Brown) Starr and Burkholder. (Bacterium pelargoni Brown, Jour. Agr. Res., 25, 1923. 372: Pseudomonas pelargoni Stapp, in Sorauer, Handb. d. Pflanzenkrank, 2, 5 Aufl., 1928, 181; Phytomonas pelargonii Bergey et al., Manual, 3rd ed., 1930. 250; Starr and Burkholder, Phytopath., \$2, 1942, 600.) From Greek, pelargus, the stork; M. L. Pelargonium, a generic name for the stork's bill geranium.

Rods: 0.67 by 1.02 microns. Capsules. Motile with a polar flagellum. Gramnegative.

Gelatin: Slow liquefaction.

Beef-agar colonies: Cream-colored, glistening, round, with delicate internal markings.

Broth: Turbid in 21 hours. Incom-

plete pellicie.

Milk: Alkaline. Clearing in bands. Nitrates not produced from nitrates

Indole formation slight.

Hydrogen sulfide produced. Lipolytic (Starr and Burkholder, Phy-

topath., \$2, 1942, 600). Slight acid but not gas from glucose,

sucrose and glycerol.

Starch hydrolysis feebly positive.

Optimum temperature 27°C, Maxi-

No growth in broth plus 3.5 per cent salt.

Acrobic.

Source: Isolated from spots on leaves of Pelargonium from District of Columbia, Maryland and New Jersey.

Habitat: Pathogenic on Pelargonium spp. and Geranium spp.

Xanthomonas phaseoli Smith) Donson. (Bacillus phaseoli Erw. Smith, Bot. Caz., 24, 1897, 192; A. A. A. S. Proc., 46, 1898, 288; Pseudomonas phaseoli Erw. Smith, U. S. Dept. Agr., Div. Veg. Phys. and Path., Bul. 28, 1901, 1; Bacterium phascoli Erw. Smith. Bact. in Rel. to Plant Dis., 1, 1905, 72; Phytomonas phaseoli Bergey et al., Manual, 1st ed., 1923, 177; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 190.) From Gr. phascolus, the bean; M. L. Phaseolus, a generic name.

Description from Burkholder, Cornell Agr. Exp. Sta. Mem. 127, 1930, 18;

and Phytopath., 22, 1932, 609. Rods: 0.87 by 1.9 microns, Motile with a polar flagellum. Gram-negative. Gelatin: Liquefaction.

Beef-extract agar colonies: Circular, amber vellow, smooth, butvrous, edges entire. Broth Turbid in 24 hours. Yellow

ring.

Milk: Casein precipitated and digested. Alkaline, Tyrosine crystals formed.

Nitrites not produced from nitrates. Indole not formed.

Hydrogen sulfide produced.

Lipolytic (Starr and Burkholder, Phytopath., 52, 1942, 600).

Acid but not gas from glucose, galactose, fructose, arabinose, xylose, maltose, lactose, sucrose, raffinose and glycerol. Alkaline reaction from salts of acetic, malic, citric and succinic acids. Mannitol, dulcitol, salicin and formic and tartaric acids not fermented.

Starch is hydrolyzed.

Aerobic.

Very slight growth in beef broth plus 4 per cent salt (Hedges, Jour. Agr. Res., 29, 1924, 243).

Distinctive character: Similar in culture to Xanthomonas campestris, X. juglandis, X. vesicatoria, etc., but they do not cross infect.

Habitat: Pathogenic on the bean (Phaseolus vulgaris), the hyacinth bean (Dolichos lablab), the lupine (Lupinus polyphillus), etc. Not pathogenic on the soy bean (Glycine sp.), nor cowpea (Vigna ap.).

20a. Xanihamonas phasroli var sojenus (Hedges) Starr and Burkbolder. (Bocterium phaseoli var. sojenus Hedges, Science, 55, 1922, 11, Jour. Agr Res, 29, 1921, 292; Phylamonas phaseols var. sojenus Burkholder, Phytopath, 50, 1930, 7; Starr and Burkholder, Phytopath, 52, 1912, 600) From M L the soy bean, Soja, a generic name, M L sojensis, of the soy bean.

Synonyms: Pseudomonas glycines Nakano, Jour. Flant Protect Tokyo, 6, 1919, 30 (Bacterium glycines Elhott, Manual Bact. Plant Path., 1928, 133, Phytomonas glycines Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 388) (See Takimoto, Jour. Plant Protect Tokyo, 18, 1931, 29; and Olabe, Jour Trop Agr. Formoss. 4, 1932, 473

Distinctive character Differs from Xanthomonas phaseoli in that it infects

the soy bean, Glycine max.

Source: Isolated from pustules on the
I caves and pods of soy bean, both in

America and in Japan.

Habitat: Pathogenic on the soy bean,
Glycine max and the common bean,
Phaseolus vulgaris.

20b. Xanthomonas phaseols var fuscans (Burkholder) Starr and Burkholder (Phylomonas phaseoli var Juscans Burkholder, Cornell Agr. Evp. Sta Mem 126, 1930, 22; Phytopath, 22, 1932, 699, Bactersum phaseols var. fuscans Okabe, Jour. Soc. Trop. Agr. Formoss, 5, 1933, 101; Pseudomonas phaseoli var fuscans Stapp, Bot. Rev., 1, 1935, 407; Starr and Burkholder, Phytopath, 52, 1912, 600) From It. fuscans, producing a brown solar.

Distinctive characters: Differs from Xanthomonas phaseoli in that it produces a deep brown color in beef-extract-peptone media and in tyrosine media. Action on maltose negative or feeble.

Source: Two cultures isolated; one from a diseased bean leaf (1924) and a diseased pod (1927) collected in Switzerland. Habitat: Pathogenic on beans, Phaseolus vulgaris, and related plants.

21. Xanthomonas plantaglinis (Thornberry and Anderson) comb. nov. (Phytomonas plantaginis Thornberry and Anderson, Phytopath., 27, 1937, 947.) From Latin, Plantago (-oginis), plantain; M. L. Plantago, a generic name.

Rods: 0 6 to 1.0 by 1.0 to 1.8 microns. Occurring singly or in chains. Capsules. Mottle with 1 to 2 polar flagells. Gramnegative.

Gelatin : Slight liquefaction.

Glucose agar slant: Growth moderate, filiform, raised, opaque, yellow and viscid.

Broth Moderately turbid with ring. Milk: Slight scidity, no reduction of

litmus. Peptonization. Nitrites not produced from nitrates.

Indole not formed

Hydrogen sulfide not produced.

No appreciable amount of gas from carbohydrates.

Starch is hydrolyzed

Optimum temperature 25°C. Minimum 12°C Maximum 35°C. Thermal death point 50°C.

Aerobic

Source · From diseased leaves of Plantago lanceolata in Illinois.

Habitat · Pathogenic on Plantago spp.

22. Xanthomonas ricinicola (Elliott) Dowson (Bacterum ricini Yoshi and Takimoto, Jour. Plant Protect. Tokyo, 15, 1928, 12. Bacterium ricinicola Elliott, Man Bact Plant Path, 1930, 193; Physiomonas ricinicola Burkholder, in Manual, 5th ed. 1939, 152; Dowson, Cent. I. Bakt., II Abt. 100, 1939, 190, Xanthomonas ricini Dowson, ibid.) From L. living on the castor bean, M. L. Ricinus, a genetic same.

Rods: 0 4 to 0 9 by 1.3 to 2 6 microns. Capsules. Short chains. Motile with polar flagella. Gram-acgative

Gelatin : Liquelaction.

Nutrient agar colonies: Lemon yellow, changing to brown. 162

Milk: Slightly acid. No coagulation. Peptonization.

Nitrites not produced from nitrates. Acid but not gas from lactose.

Starch hydrolyzed.

Optimum temperature 29° to 30°C. Maximum 39°C. Mınimum 2.5°C.

Aerobic.

Source: Isolated from leaf-spot of rastor-bean.

Habitat: Pathogenic on Ricinus communis.

23a. Xanthomonas translucens f. sp. hordei Hagborg. (Canadian Jour, of Res., 20, 1942, 317.) From L. translucens, shining through, translucent. referring to the character of the lesion produced by this pathogen. Form name from Hordeum, a generic name.

Synonyms: Bacterium translucens Jones, Johnson and Reddy, Jour. Agr. Res., 11, 1917, 637; Pseudomonas translucens, ibid.; Phytomonas translucens Bergey et al, Manual, 3rd ed., 1930, 252; Xanthomonas translucens Dowson, Cent. f. Bakt., II Abt , 100, 1939, 190.

Rods: 05 to 08 by 1 to 2.5 microns. Motile with a single polar flagellum.

Gram-negative.

Gelatin: Liquefaction

Beef-peptone agar colonies: Round, smooth, shining, amorphous except for inconspicuous somewhat irregular concentric striations within, wax-yellow tinged with old gold; margin entire.

Broth: Turbidity becomes rather

strong. Pellicle.

Milk: Soft coagulum and digestion. Milk clears Tyrosine crystals produced. Nitrites not produced from nitrates.

Indole: Slight formation. Hydrogen sulfide produced.

Lipolytic (Starr and Burkholder, Phytopath, \$2, 1942, 600)

Ammonia from peptone.

Acid but not gas from glucose, dfructose, d-mannose, d-galactose, sucrose, lactose, and sometimes salicin. No utilization of 1-rhamnose, inositol, maltose, raffinose, inulin, d-mannitol, and dulcitol.

Starch hydrolyzed.

Optimum temperature 26°C. Maximum 36°C. Minimum 6°C.

Aerobic.

Distinctive characters: All forms of Xanthomonas translucens have the same cultural characters. They differ mainly in pathogenicity. This form is pathogenic on barley, Hordeum spp.; but not on oats, Avena spp., rye, Secale cereale nor on wheat, Triticum spp.

Source: Isolated from leaves and seed of barley. Hordeum vulgare.

Habitat: Occurs naturally on barley.

 Xanthomonas translucens f. sp. undulosa (Smith, Jones and Reddy) Hagborg. (Bacterium translucens var. undulosum Smith, Jones and Reddy, Science, 50, 1919, 48; Pseudomonas translucens var. undulosa Stapp, in Sorauer, Handb. d. Pflanzenk., 2, 5 Auf., 1928, 17; Phylomonas translucens var. undulosa Hagborg, Canadian Jour. Res., 14, 1936, 347; Hagborg, Canadian Jour. Res., 20, 1942, 317.) From L. unda; M.L. undulosus, undulate, referring to the undulation of the colony. Distinctive characters: Cultural char-

acters same as all forms of Xanthomonas translucens. Pathogenic on wheat, Triticium spp., barley, Hordeum spp. and rye, Secale cereale · but not on oats, Avena spp.

Source: Isolated repeatedly from black chaff of wheat.

Habitat: Usually found on wheat causing the black chaff, and on rye.

23c. Xanthomonas translucens f. sp. seculis (Reddy, Godkin and Johnson) Hagborg. (Bacterium translucens var. secalis Reddy, Godkin and Johnson, Jour. Agr. Res., 28, 1924, 1039; Pseudomona translucens var. secalis Stapp, in Sorauer, Handb. d. Pflanzenkr., 2, 5 Aufl., 1928, 24; Phytomonas translucens var. secalis Burkholder, in Manual, 5th ed., 1939, 160; Hagborg, Canadian Jour.

Res., 20, 1942, 317.) From M.L. Secale, a generic name. Distinctive characters Cultural characters same as other forms of Xanthomonas translucens. This form pathogenic on tye Secale cereale, but not on Triticum spp., Hordeum spp. nor Avena spp.

Source: Isolated from leaf spot on rve. Secale cereale.

Habitat: Pathogenic on rve.

23d. Xanthomonas translucens f. sp hordei-arenae Hagborg (Canadian Jour Res ,20, 1942, 317.) From M L Hordeum and Arena, generic names.

Distinctive characters Cultural characters same as other forms of Xanthomonas translucens. Pathogenic on barley, Hordeum spp and oats. Atena spp , but not on wheat, Triticium spp , nor rye, Secale cereale.

Source: Isolated 6 times from barley at various places in Canada

Habitat: Occurs naturally on barley

23e. Xanthomonas translucens f sp cerealis Hagborg. (Canadian Jour Res , 20, 1942, 317.) From L., of cereal.

Distinctive characters: Cultural characters same as other forms of Xanthomonas translucens. Pathogenic on wheat, Triticum spp.; oats, Arena spp.; barley, Hordeum spp.; and rye, Secale cereale

Source: Isolated from wheat in Canada. Habitat: Occurs naturally on wheat.

24. Xanthomonas vasculorum (Cobb) Dowson. (Bacillus vascularum Cobb, Agr. Gaz. of New South Wales, 4, 1893,777; Abst. in Cent f. Bakt., II Abt , 1, 1895, 41; Bacterium vascularum Migula, Syst. d. Bakt., 2, 1900, 512, Pseudomonas vascularum Erw, Smith, U S. Dept Agr, Div. Veg. Phys and Path . Bul 28, 1901, 153; Phytomonas vascularum Bergey et al., Manual, 1st ed , 1923, 179; Dowson, Cent. f. Bakt., II Abt , 100, 1939, 190.) From L vasculum, a small vessel; M. L. the vascular system.

Nore: Erw. Smith (Bact. in Rel. to

Plant Dis., 5, 1914, 88) states that probably Spegazzini (El Polville de la Cana de Azucar, June. 1895. La Plata. Supl. Rev. Azuc., Buenos Aires, No. 16, 1895) reported the disease caused by Xanthomonas tasculorum but that Bacillus sacchars Spegazzini which he claimed to be the pathogen, was a saprophyte

Description from Smith (loc. cit., 54). Rods: 0.4 by 1.0 microns Motile with a polar flagellum. Gram-variable.

Gelatin: Liquefaction feeble. Liquefaction good (Burkholder).

Beef-extract agar colonies Pale yellow smooth, glistening, not poticeably viscid. Broth . Good growth.

Milk: Alkaline Nitrites not produced from nitrates. Lipolytic (Starr and Burkholder, Phy-

topath . \$2, 1942, 600). Acid but not gas from glucose, fructose and giveerol.

Starch hydrolyzed (Burkholder).

Optimum temperature 30°C. Maximum 35° to 37.5°C (Elliott, loc cit ).

Habitat, Pathorenic on sugar cane. Saccharum officinarum, causing a bacterial gummosis.

25 Xanthomonas vesicatoria (Doidge) Dowson. (Bacterium tesicatorium Doidge, Jour Dept Agr. S Africa, 1, 1920, 718, also Ann Appl. Biol , 7, 1921, 428. Pseudomonas resiculoria Stapp, in Sorauer, Handb d Pflanzenkrank., 2, 5 Aufl., 1928, 259, Phytomonas tesicatoria Bergey et al , Manual, 3rd ed , 1930, 253; Donson, Cent f Bakt, II Abt., 100, 1939, 190 ) From L vesica, a blister; M. L. resicutorius, causing blisters.

Synonyms: Gardner and Kendrick (Phytopath , 13, 1923, 307) list Pseudomonas exitiosa Gardner and Kendrick (Phytopath , 11, 1921, 55; Bacterium exitiosum Gardner and Kendrick, Jour. Agr. Res., 21, 1921, 141; Phytomonas exitiosa Bergey et al., Manual, 1st ed., 1923, 183) and an unnamed species, Higgins (Phytopath, 12, 1922, 513).

Rods: 06 to 07 by 10 to 1.5 microns

Motile with a polar flagellum. Capsules, Gram-positive. Gram-negative (Gardner and Kendrick; and Higgins).

Gelatin: Liquefaction.

Nutrient agar colonies: Good growth. Circular, wet-shining, Naples yellow, edges entire.

Milk: Casein precipitated and slowly digested. Tyrosine crystals.

Nitrites not produced from nitrates.

Indele not formed.

Hydrogen sulfide produced (Burk-hider).
Lindwig (Starr and Burkholder Phy-

Lipolytic (Starr and Burkholder, Phytopath , 52, 1942, 600).

Acid but not gas from glucose, fructose, sucrose, lactose, galactose, glycerol and dextrin.

and dextrin.

Certain strains hydrolyze starch, others
do not (Burkholder and Li, Phytopath.,

81, 1941, 753). Optimum temperature 30°C.

Source: Isolated from spotted tomato fruits in South Africa.

Habitat: Pathogen on tomatoes, Lycopersicon esculentum and peppers, Capsicum annuum.

25a. Xanthomonas resicatoria var. raphani (White) Starr and Burkholder. (Bacterium resicatoria var. raphani White, Phytopath, 20, 1930, 653; Phytomonas resicatoria var. raphani Burkholder, in Manual, 5th ed, 1939, 15th; Starr and Burkholder, Phytopath., 32, 1942, 660.) From M. L. Raphanus, the radish, a generic name.

Distinctive characters: Cultural characters similar to Xanthomonas vesicatoria, but differs in that it is able to attack radishes, turnips, and other crucifers. Differs from Xanthomonas campestris in that it does not cause a vascular diseaso, and differs from Xanthomonas campestrie var. armoraciae in that it is not pathogenic on horseradish.

Source: Isolated from leaf spots of radish and turnips in Indiana.

Habitat: Pathogenic on radish, turnips, and other crucifers; and on tomato and pepper. 26. Xanthomonas nakatae (Okabe) Dowson. (Bacterium nakatae Type B, Okabe, Jour. Soc. Trop. Agr., Formosa, 5, 1933, 161; Phytomonas nakatae Burkholder, in Manual, 5th ed., 1933, 161; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 12.) Named for Nakata, the Japanese plant pathologist.

Rods: 0.3 to 0.4 by 1.1 to 2.5 microns. Capsules. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefaction. Brown color.

Beef-extract agar colonies: Amber yellow, round, smooth, glistening, margins entire. Brown.

Broth: Moderate turbidity with yellow ring. Medium turns brown.

Milk: Casein is precipitated and digested. Tyrosine crystals. Brown color. Nitrites not produced from nitrates. Indole not formed.

Slight amount H.S produced.

Acid but not gas from glucose, sucrose, maltose and lactose.

Starch: Strong diastatic action.

Optimum temperature 30° to 32°C. Maximum 30°C. Minimum 10°C.

Maximum 39°C. Minimum 10°C.

No growth in beef extract broth plus
2 per cent salt.

Aerobic.

Distinctive character: Differs from Type A in that it produces a brown pigment in culture. (Description of Type A not seen.)

Source: Isolated from water-soaked to brown leaf spots on jute.

Habitat : Pathogenic on jute, Corchorus capsularis,

27. Kanthomonas papavericola (Bryan and McWhorter) Dowson. (Bacterium papavericola Bryan and McWhorter, Jour. Agr. Res., 40, 1930, 9; Phytomonas paparericola Bergey et al., Manual, 4th ed., 1934, 266; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 190.) From L. papaver, poppy; -cola, dweller; M. L. Papaver, a generic name.

Rods: 0.6 to 0 7 by 1 to 1.7 microns. Chains. Capsules. Motile with a single polar flagellum. Gram-negative. Gelatin: Liquefaction.

Beef agar colonies: Mustard yellow to primuline yellow, circular, margins entire.

Broth: Turbidity prompt with a yellow

ring and an incomplete pellicle.

Milk: Soft coagulation, peptonization and production of tyrosine crystals

Nitrates: A weak reaction for patrites after 10 days.

Indole not formed.

Hydrogen sulfide is produced.

Lipolytic (Starr and Burkholder, Phytopath., \$2, 1942, 600).

Acid but not gas from glucose, galactose, fructose, sucrose, lactose, maltose,

glycerol and mannitol. Starch is hydrolyzed

Optimum temperature 25° to 30°C. Maximum 35°C.

No growth in broth plus 5 per cent salt. Aerobie.

Source: Isolated from black spots on leaves, buds and pods of poppy

Habitat: Pathogenic on poppy, Paparer rhocas.

28. Xanthomonas alfalfae (Riker et al.) Dowson. (Bactersum alfalfae Riker, Jones and Davis, Jour. Agr Res , 51, 1935, 177; Phytomonas alfalfae Riker et al., ibid.; Pseudomonas alfalfae Riker et al., ibid ; Dowson, Trans Brit Mycol Soc., 26, 1943, 11.) From Spanish, of alfalfa.

Rods: 0.45 by 2.4 microns. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefied. Nutrient agar stroke: Growth abun-

dant, filiform, smooth, glistening, butyrous, pale reliew. Broth: Turbid in 21 hours. Light

sediment. Milk: Casein is precipitated and di-

gested. Ammonia formed slowly in a nitrate medium.

Carbohydrates: No seid in yeast broth plus sugare.

Starch is hydrolyzed Aembie

Optimum temperature 24° to 32°C. Maximum below 36°C. Minimum below

Source: Six single cell cultures isolated from diseased alfalfa.

Habitst: Pathogenic on the leaves of alfalfa, Medicago satira,

29. Xanthomonas acernea (Ogawa) comb. nov. (Pseudomonas acernea Ogawa, Ann. Phyt. Soc. Japan, 7, 1937, 123; Phytomonas acernea Ark, Phytopath., 29, 1939, 968.) From L. acerneus, of the maple.

Rods: 0.2 to 0.6 by 0 5 to 1.2 microns. Motile with one polar flagellum. Gram-

neentive.

Gelatin: Liquified.

Agar colonies. Round, smooth, convex, white to citron yellow, glistening, translucent with amorphous structure. Broth : Turbid

Milk - Slowly cleared, slightly acid.

No coagulation. Natrates produced from nitrates.

Hydrogen sulfide produced. No gas produced in pentone water plus sugars.

Starch not hydrolyzed

Optimum temperature about 32°C. Thermal death point 59°C. Aerobic.

Source · From diseased leaves of Acer trifidum in Japan.

Habitat : Causes a disease in Acer spp. and in Aesculus turbinata and Koelrentersa ponsculata

30 Xanthomonas carotae (Kendrick) Dowson. (Phytomonas carolae Kendrick, Jour. Agr. Res , 49, 1931, 501; Pseudomonas carotae Kendrick, ibid. Donson, Cent f. Balt., II Abt., 100, 1939, 190 ) From L. carola, the carrot.

Rods: 042 to 0.85 by 138 to 275 microns. Motile with 1 or 2 mlar flagella.

Gram-negative. Gelatin : Liquefied.

Potato glucore agar: Colonies round. smooth, glistening, margins entire, straw yellow in color,

Milk: Casein precipitated and milk cleared; alkaline.

Nitrites not produced from nitrates.

Indole not formed.

Acid, no gas, from glucose, d-galactose, xylose, d-mannose, l-arabinose, sucrose, lactose, raffinose, trehalose, d-mannitol and glycerol No acid from maltose and rhamnose.

Starch not hydrolyzed.

Optimum temperature 25° to 30°C. Tolerates 4 per cent salt at pH 7

Aerobic. Source Two original isolations from

diseased carrots and a reisolation from inoculated carrots were used for the description.

Habitat. Pathogenic on leaves of Daucus carota var satura.

31. Xanthomonas hederae (Arnaud) Dowson (Bacterium hederae Arnaud, Compt. rend Acad Sci., Paris, 171, 1920, 121; Phytomonas hederae Burkholder and Guterman, Phytopath, 22, 1932, 783, Dowson, Cent. f. Bakt, II Abt., 100, 1939, 190 ) From L hedera, ivy; M L. Hedera, a generic name.

Description taken from Burkholder and Guterman (loc. cit.).

Rods: 06 by 213 microns. Motile with a single polar flagellum. Gramnegative.

Gelatin: Liquefied

Beef-extract-agar slants · Growth good, filiform, amber vellow, butyrous.

Broth : Turbid.

Milk: Casein is precipitated and digested. Milk becomes alkaline.

Nitrites not produced from nitrates. Hydrogen sulfide is formed.

Indole not formed.

Not lipolytic (Starr and Burkholder, Phytopath , 32, 1942, 600)

Acid from glucose, fructose, galactose, xylose, sucrose, lactose and glycerol. Alkalı from salts of acetic, citric, lactic, malic and succinic acids The following are not utilized arabinose, rhamnose, maltose, salicin, starch, cellulose and formic acid.

Aerobic, facultative,

Source: Isolated from diseased ivy leaves.

Habitat: Pathogenic on ivy, Hedera helix.

32. Xanthomonas phormicola (Takimoto) Dowson (Bacterium phormicola Takimoto, Jour. Plant Protect., 20, 1933. 777; Phytomonas phormicola Burkholder. in Manual, 5th ed., 1939, 159; Dowson. Trans. Brit. Mycol. Soc., 26, 1943, 12.) From M. L. Phormium, a generic name.

Description translated by Dr. K. Togashi.

Rods: 0.5 to 06 by 1 to 2 microns Motile, with a single flagellum. Gramnegative.

Gelatin: Liquefied.

Agar colonies: Light yellow, then wavy yellow; butyrous, then viscid.

Broth: Turbid, pellicle formed.

Milk: Casein coagulated slowly and precipitated, then digested. Alkaline. Nitrites not produced from nitrates.

Indole not formed

Hydrogen sulfide produced.

No gas from sucrose, glucose, lactose and glycerol.

No acid from various sugars in broth. Optimum temperature about 29°C Maximum 39°C. Minimum about 0°C. Aerobic.

Source: Species isolated from New Zealand flax, Phormium tenax.

Habitat: Causes a leaf stripe of Phormium tenax.

33 Xanthomonas geranii (Burkholder) Dowson. (Phytomonas geranii Burkholder, Phytopath , 27, 1937, 560; Dowson, Cent. f. Bakt., II Abt., 100, 1939, 190) From Greek, geranos, crane; M. L. Geranium, a generic name.

Rods : 075 to 20 microns. Motile with a single polar flagellum. Gramnegative

Gelatin: Liquefied.

Beef-extract agar slants: Moderate to good filiform growth, glistening, primuline vellow. Develops in 24 hours.

Broth: Turbid in 24 hours. No pellicle but a moderate sediment.

Milk: Becomes clear with a heavy casein precipitate. Peptonization with crystal formation.

Nitrates reduced to ammonia

Indole not formed.

Hydrogen sulfide formed

Lipolytic (Starr and Burkholder, Phytopath., 32, 1942, 600).

Acid from glucose, galactose, fructose. xylose, rhamnose, lactose, sucrose, mifinose and glycerol. Alkaline reaction from salts of citric, malie, malonie and succime acid No growth in arabinose or formic, hippurie, maleic or tartane neid.

Starch not hydrolyzed

Aerobe.

Distinctive characters Pathogenic on Geranium app., not on the house geranium, Pelargonium hortorum In culture similar to Xanthomonas pelargonis

Source: Three cultures isolated from Geranium zanguineum

Habitat: Pathogenic on Geranium san guineum, G. maculatum, G protense and G. sylvaticum.

Xanthomones antirrhini (Taki moto) Donson, (Pseudomonas antirrhini Takimoto, Bot Mag Tukyo, 34, 1920, 237: Boctersum antirrhins I Bott, Man. Bact. Plant Path , 1930, 93, Phylo monat antirrhim Magron, in Hauduny et al., Diet. d beet path , Paris, 1937, 331; Dowson, Trans Brit Mycol Soc. 26, 1913, 11.) I'rom Gr antirrhinum, anapdragon; M L Anterhinum, a generic name.

Description from I thatt (loc cit )

Rods: 0.3 to 0 4 by 0 5 to 1 2 microns Motile with polar flagella Capsules Gram-negative

Gelatin: Liquefied

Acres. colonies Round, glistenies, white, later yellow

Milk: Congulated and even digreted Nitrites are produced from nitrates No gas produced

Acrobic.

Optimum temperature 26° to 27°C. Maximum 34°C.

Habitat: Causes a leaf spot of Antirrhinum majus.

35. Xauthomonas heterocea (Vzoroff) comb. nor. (Phytomonas heterocea Vzoroff, Bull. North Caucasian Plant Prot. Sta. Roztoff-on-Don, 6-7, 1930, 263; Bactersum heteroceum Burgwitz, Phytopathogenic bacteria, Leningrad, 1935, 135 ) From Gr. heterus, another, different.

Description taken from Rev. App. Myc , 10, 1931, 628

Rods . 0 4 to 0 6 by 1 0 to 20 microns. Motile Gram-negative.

Gelatin Slow liquefaction.

Agar colonies: Round, conver, smooth, semi-transparent, glistening, sellow to amber, 2 mm in diameter. Pitted sur-

Milk No congulation. At first acid. later alkaline.

Natrates produced from natrates

Indole not formed

Hydrogen sulfide produced,

teid from glucose, galactose, arabinose, vylose, sucrose, maltose, salicin, glycerol and mannitol Does not ferment hetose, mulin, ethyl alcohol, esculin, adomtol or dulcitol

Optimum temperature 25° to 30°C. Source Isolated from diseased tobacco

in the North Caucasus Habitat . Pathogenic on Nicoliana

taheeum

36 Xanthomonas gummisudans (Me-Culloch) Starr and Burkholder, (Bacterium gummieudans McCulloch, Phytorath , 14, 1921, 63, alen Jour. Agr. Hee , 27, 1921, 221; Pseudamonas gummisudans Stapp, in Sormet, Handb, d. Pflantenkrank . 2, 5 Aufl , 1928, 51; Phylomonas gummisudant Bergey et al., Manual, 2nd ed , 1925, 201; Starr and Burkholder, Phytopath , 32, 1912, 660 ) From L gummi, grint; endans, entating, dripperg Hole: 86 to 85 by 1 to 25 microns

Capsules. Motile with a polar flagellum. Gram-negative.

Gelatin: Liquefied.

Beef-peptone agar colonies: Amber yellow, circular, transparent, smooth, with definite margins.

Broth: Moderately turbid with a yellow ring.

Milk: Soft curd which is digested with formation of tyrosine crystals.

Nitrites not produced from nitrates.
Indole not produced.

Hydrogen sulfide produced. Lipolytic (Starr and Burkholder, loc.

cit.).

Acid from glucose and sucrose.

Optimum temperature 30°C. Maxi-

mum 36°C. Minimum 2°C.

Source: From gummy lesions on gladiolus leaves.

Habitat: Pathogenic on leaves of gladioli.

37. Xauthomonas lactucae (Yamamoto) Dowson. (Bacterium lactucae Yamamoto, Jour. Plant Protect., 21, 1934, 532; Phytomonas lactucae Bergey et al., Manual, 5th ed., 1939, 163; Dowson, Trans. Brit. Mycol. Soc., 26, 1943, 12.) From L. lactuca, lettuce; M. L. Lactuca, a generic name.

Description translated by Dr. K Togashi.

Rods: 0 6 to 0.8 by 1.75 to 2.8 microns. Motile with a polar flagellum. Gramnegative.

Gelatin: Liquefaction slow.

Agar colonies: Cırcular, convex, margin entire, surface smooth, wet-shining,

yellow. Broth. Turbid. Ring and pellicle

Milk: Slow peptonization. Nitrites not produced from nitrates.

Indole not produced. Hydrogen sulfide produced.

Acid, no gas, from glucose, sucrose, and lactose in bouillon; no acid from glycerol in bouillon.

Optimum temperature 28°C. Maximum 35°C. Minimum below 2°C.

Aerobic.

Source: Isolated from leaf spot of lettuce.

Habitat: Pathogenic on leaves of asparagus lettuce, Lactuca sativa var. anaustata.

38. Xanthomonas nigromaculans (Takimoto) Dowson. (Bacterium nigromaculans Takimoto, Jour. Plant Protect, Tokyo, 14, 1927, 522; Phytomonas nigromaculans Magrou, in Hauduroy et al., Diet. d. Bact. Path., Paris, 1937, 387; Dowson, Trans. Brit. Mycol. Soc., 28, 1943, 12.) From L. niger, black; maculans, spotting.

Description translated by Dr. K. Togashi.

Rods: 0.6 to 0.9 by 1.5 to 2.8 microns. Motile with 1 or 2 polar flagella. Gramnegative.

Gelatin: Liquefaction.

Agar colonies: Yellow, circular, margins entire, smooth, glistening.

Broth: Growth moderate with yellow pellicle.

Milk: Coagulation and digestion of the casein.

Nitrites not produced from nitrates.

Indole not produced.

No acid or gas from glucose, sucrose, lactose, mannitol and glycerol in peptone water.

water.

Optimum temperature 27° to 28°C.

Maximum 33°C. Minimum 0°C.

Aerobic.

Source: Isolated from lesions on leaf and petioles of burdock.

Habitat: Pathogenic on leaves and petioles of Arctium lappa, the burdock.

39. Xanthomonss oryzae (Uyeda and Ishiyama) Dowson. (Peeudomonas oryzae Uyeda and Ishiyama, Proc. Third Pan-Facific Sci. Congr., Tokyo, 9, 1926, 2112; Bacterium oryzae Nakata, see Elliott, Man. Bact. Plant Path., 1930, 172; Phytomonas oryzae Magrou, in Hauduroy et al., Dict. d. Bact. Path., Paris, 1937, 388; Dowson, Trans. Brit.

Mycol. Soc., 25, 1943, 12.) From Gr. oryza, rice; M. L. Oryza, a generic name

Probable synonym: Pseudomonas itoana Tochinai, Ann. Phytopath. Soc Japan, 2, 1932, 456; Bacterium stoanum Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 74; Phytomonas itoana Magrou, in Hauduroy et al., Dict. d. Bact. Path., Paris, 1937, 370

Rods: 05 to 08 by 10 to 20 microns. Motile with a polar flagellum Gramnegative.

Gelatin: No liquefaction.

Nutrient agar colonies Round, smooth, glistening, wax yellow.

Milk: Slightly acid.

Nitrites are not produced from nitrates. Hydrogen sulfide produced.

Acid but no gas from glucose, lactose and sucrose.

Optimum temperature 26° to 30°C.

Strict aerobe. Source: Isolated from a leaf blight of

Habitat: Pathogenic on rice, Oryzo sativa.

40. Kanthomonas celebensis (Gaumann) Dowson. (Pseudomonas celebensis Gaumann, Ztschr. f. Pflanzenkrank., 33, 1923, 11; Meded Inst. voor Plantenziek., Buitenzorg, 59, 1923, 17; Bacterium celebense Elliott, Man Bact. Plant Path., 1930, 103; Phytomonas celebensis Magrou, in Hauduroy et al., Dict. d. Bact. Path , Paris, 1937, 343; Dowson, Trans. Brit Mycol Soc., 25, 1913, 11.) From M L of the island Celebes.

Rods: 0 9 by 1.5 microns Motile by a polar flagellum. Gram-negative.

Agar colonies: Grayish yellow.

Broth: Thin pellicle.

Milk: Coagulated and cleared.

Nitrites not produced from nitrates. Sodium selenite: Brick red

Starch is hydrolyzed.

Source: From yascular bundles of diseased bananas in Celebes.

Habitat: Causes the blood disease of banana.

Xanthomonas panici (Elliott) comb. nov. (Bacterium panies Elliott, Jour. Agr. Res., 26, 1923, 157; Pseudomonas panici Stapp, in Soraner, Handb. d. Pflanzenkrank., 2, 5 Aufl., 1928, 27; Phytomonus panici Bergey et al., Manual, 3rd ed., 1930, 269 ) From M. L. Panicum, a ceneric pame.

Rods: 0 69 by 1 66 microns. Capsules. Motile by 1 or rarely 2 polar flagella. Gram-negative.

Gelatin: Liquefaction slow.

Beef agar colonies: Round, white, smooth, glistening, margins at first entire. later undulate.

Broth: Moderate turbidity in 24 hours.

Thin pellicle. Medium brownish. Milk : Alkaline and clears.

Nitrites are produced from nitrates Indole not produced.

Hydrogen sulfide produced.

No gas from carbohydrates. Starch: Hydrolysis moderate

Optimum temperature 33°C, Maxi-

mum 45°C. Minimum 5°C Optimum pH 6.15 to 6.3. pH range 54 to 100.

Aerobic

Distinctive characters Differs from Pseudomonas andropogoni in that it liquefies gelatin, produces nitrites from nitrates, and does not infect sorghum and

broom corn. Source Isolation from water soaked lesions on leaves, sheaths and culms of millet collected in Wisconsin and in S.

Dakota Habitat Pathogenic on prose millet.

Panicum miliaceum.

Kanthomonas proteamaculans (Paine and Stansfield) comb. nov. (Pseudomonus proteumuculans Paine and Stansfield, Ann. Appl. Biol., 6, 1919, 38; Phytomonas proteamaculans Bergey et al Manual, 3rd ed , 1930, 247, Bacterium proteamaculans Elliott, Man Bact. Plant Path., 1930, 186,) From M. L. Protea. a generic name; maculans, spotting.

Rods; 0 6 to 0.8 by 0.8 to 1.6 microns

Motile with 1 to 3 polar flagella. Grampositive.

Gelatin: Liquefaction.

Agar slant: Growth wet-shining, durty white with a faint yellow tinge.

Broth: Turbid in 21 hours. Slight ring.

Milk: Acid with soft curd after 2 days. Later a separation of whey.

Nitrites are produced from nitrates.

Acid and gas from glucose, sucrose and
mannitol. No acid or gas from lactose.

Starch: Slight hydrolysis, Source: Repeated isolation from a leafspot of *Protea* in England.

Habitat: Pathogenic on Protes cy-

43. Xanthomonas manihotis (Arthaud-Berthet) comb. nov. (Bacillus manihotus Arthaud-Berthet by Bondar, Chacaras and Quintaes 5(4), 1912, 15; Bacillus manihot Bondar (and Arthaud-Berthet), Bol. Agric., Sio Paulo, 16, 1915, 513; Bacterium manihotus Drummond and Hipolito, Ceres, 2, 1911, 293; Phylomonas manihotis Vicças, Rev. d Agr., Pieracicaba, 16, 1910, 475) From M. L. Manihotus, a generic name

Description from Burkholder, Phytopath., 52, 1912, 147

Rods: 0 35 to 0 93 by 1.4 to 2.8 microns. Gram-negative and mostly non-motile. One isolate showed a few cells with 1 polar flagellum Amaral (Instit. Biol., São Paulo, Arq, 15, 1912, 120) states that the species is motile with one polar flagellum.

Gelatin: Liquefaction.

Beef-extract-peptone agar: Streaks raised, ivory-color, smooth, shiny, with edges entire.

Potato-glucose agar: Growth abundant, white to hyaline, very mucoid. Broth: Turbid with a whitish granular

ring.

Litmus milk: Litmus reduced and milk clears. With return of color, litmus

is purple,
Indole not formed.
Hydrogen sulfide is formed

Nitrites produced from nitrates (Drummond and Hipolito, loc. cit.).

Asparagine not used as a nitrogen and carbon source. No growth in nitrate synthetic broth.

Weak growth but slight acid production in synthetic medium plus glucose, dagalactose, d-fructose, d-xylose, maltose and sucrose. No growth in rhamnose, l-arabinose, d-lactose, glycerol, mannitol and salicin. Good growth with alkaline reaction in same medium plus salts of the following acids: acetic, eitric, malic, maleic and succinic. The salts of formic, hippuric, lactic and tartaric acids were not utilized.

Starch not hydrolyzed. Amaral (loc. cit.) finds hydrolysis.

Lipolytic action slight.

Acrobic.

Optimum temperature 30°C. Maximum 38°C. Minimum 5°C.

Source: First isolated from the cassava, Manihotus utilissima in Brazil.

Habitat: Produces a wilt disease on various species of Manihotus.

44. Xanthomonas rubrisubalbicans (Christopher and Edgerton) comb. nor. (Phylomonas rubrisubalbicans Christopher and Edgerton, Jour. Agr. Res., 41, 1990, 266; Bacterium rubrisubalbicans Burgwitz, Phytopathogenic Bacteria, Leningrad, 1935, 105.) From L. ruber, red; subalbicans, nearly white.

Rods: Short with polar flagella. Cap-

sules. Gram-negative.

Gelatin: No liquefaction.
Bacto-glucose agar colonies: Circular,
glistening, viscid, milky gray to buff.
Margins translucent, entire.

Broth: Turbid after 24 hours. Pollicle

and a ropy sediment.

Indole produced.

Hydrogen sulfide produced. No gas from carbohydrates.

Starch hydrolyzed.

Optimum temperature 30°C. Optimum pH 6 8 to 8 0.

Source: Isolated many times from mottled stripe of sugar cane in Louisiana. Habitat: Pathogenic on sugar cane, Johnson's grass and sorghum.

45. Xanthomonas cannae (Bryan) comb. nov. (Bacterium cannae Bryan, Jour. Agr Rea., £1, 1921, 152, Phylomonas cannae Bergey et al., Manual, 1st ed., 1923, 188; Pacudomonas cannae Stapp, et Sorauer, Handb d. Phantenkrank, £, 5 Aufl., 1928, 63 From Gr canna, a reed; M. L. Canna, a generie rume

Rods: 0 5 to 0.7 by 1 0 to 20 microns Motile with 1 to 3 polar flagella Cap-

sules. Gram-negative

Gelatin: Slow Inquesaction Agar streaks: Filiform, white, moist, with thin margins and granular centers

Broth. Turbid, heavy sediment

Milk: Alkaline and clears

Nitrites are produced from mirates

Indole not produced

Hydrogen sulfide produced
Optimum temperature 35°C Maxi
mum 40°C. Minimum 5°C

Aerobic.

Source: Isolated from diseased canna leaves collected in Washington, D. C. and in Illinois.

Habitat: Causes disease in Canna

46. Xanthomonas zingtberi (Uyeda) comb. nov. (Uyeda) Cent f Bakt, II Aht., 17, 1907, 383, Pesudomonas zingberi Uyeda, Rept. Imp Agr. Exp Sta, Japan, No. 35, 1908, 114; Bacterium zingtberi Nakata, ase Elliott, Man Bact Plant Path., 1950, 266, Phytomonas zingberi Magrou, in Handuroy, cat fl. Diet d Bact. Path., Paris, 1937, 437) From L zingtberis, ginger; M. L. Zingiber, a generic nature.

Description from Stapp, in Sorauer,

Handb. d. Pflanzenkrank, 2, 5 Aufl., 1928, 65.

Rods 0 5 to 1 1 by 0 75 to 1 8 microns. Non-motile at first, later a polar flagellum. Gram-negative.

Gelatin: Liquefaction

Agar colonies: White.

Milk: Coagulation and peptonization of the casein.

Natrates are produced from natrates.

Indole not formed

Hydrogen sulfide is formed.

No gas from glucose

ber officinale.

Optimum temperature 28°C. Maximum 40°C. Minimum 5°C

Source Isolated from ginger plant showing a rot at the base of the sprouts Habitat Pathogenic on ginger, Zingi-

47. Xanthomouss conjact (Uyeda) comb noe (Pseudomonas conjact Uyeda, Bot Mag. Tokyo, 24, 1910, 182; Bacterium conjac Elholt, Man Bact. Plant Path , 1930, 121, Phytomonas conjac Magrou, in flauduroy et al , Dict. d. Bact. Path , Paris, 1937, 347.) From M. L. conjac, the specific name of the plant which this species attacks

Description from Elliott (loc cit.), Rods 0.75 to 1.0 by 1.5 microns. Motile with 1 to 4 polar flagella Grampositive

Gelatin colonies Circular to irregular,

Broth Pellicle formed.

Mulk Congulation

Milk Coagulation Coniac Liquefied

Nitrites produced from nitrates Indole produced.

Hydrogen sulfide produced Gas from glucose

Pavorable temperature 24°C.

Habitat · Pathogenic on Amorphophallus Loniac.

Appendix I:\* The following organisms placed in the genus Pseudomonas apparently belong in Kanthomonas Some may even be plant pathogens although they were

<sup>\*</sup> Prepared by Prof Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1943.

isolated from water, soil and similar sources. Pigment is usually yellow and is not water-soluble.

Key to yellow and other chromogenic species in genus Pseudomonas.

- Colonies yellow.
  - a. Gelatin liquefied.
    - b. Nitrites produced from nitrates.
      - c. Acid and gas produced from glucose.
      - 1. Pseudomonas fermentans.
      - cc. Acid but no gas from glucose,
        - 2. Pseudomonas trifolii.
      - 3. Pseudomonas xanthe.
      - ccc. Action on glucose not recorded.
    - 4. Pseudomonas caudata.
    - bb. Nitrites not produced from nitrates.
      - c. Litmus milk acid or ferment lactose. Pseudomonas verlurida.
        - 6. Pseudomonas iridescens.
      - cc. Litmus milk not coagulated. Yellow sediment.
      - 7. Pseudomonas turcosa.
      - cce. Litmus milk slimy, alkaline. 8. Pseudomonas ochracea.
  - aa. No liquefaction of relatin.
    - b. Nitrites produced from nitrates.
      - c. Litmus milk, slow coagulation,
        - 9. Pseudomonas cerevisiae.
      - cc. Litmus milk, acid but no digestion.
      - 10. Pseudomonas arguta.
      - cec. No growth in litmus milk,
      - 11. Pseudomonas subcreta.
      - ecce. Action on litmus milk, not recorded.
    - 12. Pseudomonas pictorum.
    - bb. Nitrites not produced from nitrates. c. Butter colored pellicle on litmus milk.
      - Pseudomonas lacunogenes.
      - cc. No surface pellicle.
      - Pseudomonas segnis.
- 2. Colonies on gelatin blue center surrounded by yellow zone with peripheral green zone.
  - a. Gelatin liquefied.
    - Nitrites produced from nitrates.
      - 15. Pseudomonas lemonnieri.
- 1. Pseudomonas fermentans von Wolzogen Kuhr. (von Wolzogen Kuhr, Cent. f. Bakt , II Abt., 85, 1932, 228; Flavobacterium fermentans Bergey et al., Manual, 4th ed , 1934, 155) Latin, fermento, to ferment.
  - Rods: 0.4 to 0.6 by 1.7 to 3.4 microns.

with rounded ends, occurring singly and in pairs. Motile, with a single or occasionally 2 or 3 polar flagella. Gramnegative.

Gelatin colonies: Circular, grayish, with rapid liquefaction.

Gelatin stab : Liquefaction crateriform.

Agar colonies: Circular, slightly conver, opaque, gray by reflected, and light-brown by transmitted light

Agar slant: Gray, becoming yellowish Broth: Turbid with pellicle. Litmus milk: Acid.

Potato: Gray to yellowish growth

Indole is formed
Nitrites produced from nitrates

Nitrites produced from nitrates
Acid and visible gas from glucose,
lactose and sucrose.

Acetylmethylcarbinol is formed Ammonia is formed from peptone and

asparagin. Hydrogen aulfide is formed

Starch is hydrolyzed Lipase is formed. Catalase positive Aerobic, facultative

Optimum temperature 37°C.

Distinctive character Produces gas in lactose fermentation tubes

Source. Ten cultures from the larvae of a midge (Chironomus plumosus) and from filtered water.

Habitat: Unknown.

2. Pseudomonas trifoli Huss. (Huss, Cent. f. Bakt., II Abt., 19, 1907, 68; Platobacterium trifoli Bergey et al., Manual, 1st ed., 1923, 111) From Latin, tres (tri.), three; folium, leaf, M. I. Trifolium, clover.

Possible synonym Bacillus annulatus Wright. (Wright, Memoirs Nat. Acad. Sci., 7, 1893, 443; Pseudomonas annulata Chester, Man. Determ. Bact, 1901, 315, Relationship to Bacillus annulatus Xumermann uncertain. Die Bakt unserer Trink- und Nutrafisser, Chemaitz, II Reihe, 1809, 30; Flandostertum annulatum Bergey et al , Manual, 1st ed., 1923, 110,)

According to Mack (Cent. I. Bakt., II Abt., 85, 1036, 218) the following organism is to be regarded as identical with Pseudomonas trifolii: Bacillus mesentericus aureus Winkler (Cent. I. Bakt., II Abt., 5, 1850, 577) regarded by Burri (Cent. I. Bakt., II Abt., 10, 1902, 756) and Duggeli (Cent. I. Bakt., II Abt., 12, 1901, 602) as identical with the organism which Düggeli (loc. ct.), names Bacterium herbicola aureum. The organism studied as Bacterium herbicola by Höttig (Cent. f. Bakt., H. Abt., 34, 1931, 231) is not regarded as identical with the Burri and Düggeli organism by Mack. Beijennek (Cent. f. Bakt., H. Abt., 16, 1905, 260) states that Bacillus herbicola of Burri and Düggeli is identical with his Bacillus anglomerans (Botan. Zig., 1888, 749) It so, this biomoid has priority.

Rods. 0 5 to 0 7 by 0 75 to 2 0 microns, occurring singly, in pairs and in chains. Mottle, possessing a single polar flagellum. Gram-negative.

Gram-negative. Gelatin colonies: Convex, smooth, moist, glistening, gravish-yellow.

Gelatin stab Napiform liquefaction Agar colonies Small, circular, grayish,

becoming brownish-yellow

Agar slant. Yellowish, becoming brownish-yellow streak, lacerate margin.

Broth Turbid, with grayish-yellow

Litmus milk: Slowly coagulated; alkaline; with yellow ring.

Potato: Thick, yellowish, flat, smooth, glistening

Hydrogen sulfide produced Indole is formed

Acid from glucose, sucrose, xylose, arabinose, and mannitol. No acid from lactors.

Nitrites produced from nitrates. Cultures have an agrecable odor.

Cultures have at Volutin formed.

Aerobic, facultative.

Optimum temperature 33° to 35°C. Source Isolated from clover hay.

Habitat Evidently a common organism on the leaves of plants.

3. Pseudomonas xanthe Zettnow. (Zettnow, Cent. f. Bakt. I Abt., Orig., 77, 1915, 220; Flarobacterium zettnowi Bergey et al., Manual, 1st ed., 1923, 112, Flarobacterium zanthium (sie) Bergey et al., Manual, 3rd ed., 1930, 145.) From Gr. zanthu, yellow

Rods: 0.5 to 0.6 by 0 4 to 1.4 microns. Motile, possessing a single or occasionally two or more very long (20 microns) polar flagella. Gram-negative.

Gelatin colonies: Circular, yellow,

granular.

Gelatin stab: Palc-vellow surface growth. Brownish yellow under surface colonies. Saccate liquefaction.

Agar slant: Dark vellow, glistening, with dark yellow sediment in water of condensation. Pigment not water-soluble.

Broth : Turbid.

Litmus milk. Slightly acid. Litmus reduced.

Potato: Grayish yellow to brownish growth.

Indole formed.

Nitrites are produced from nitrates. Acid formed in glucose.

Starch bydrolyzed.

Blood serum not liquefied.

Aerobic, facultative Optimum temperature 30°C. Source. Air contamination.

4. Pseudomonas caudata (Wright) Conn. (Bacillus caudatus Wright. Memoirs Nat. Acad Sci., 7, 1895, 444; Bacterium caudatus Chester, Annual Rept. Del Col. Agr Evp Sta , 9, 1897, 107, Conn. Jour Agr Res , 16, 1919, 313; Flatobacterium caudatum Bergey et al , Manual, 1st ed., 1923, 109) From Latin, cauda, tail Rods. Long, granular, slender, occurring

singly, in pairs and in chains Appear like cocci in old cultures Motile, possessing a polar flagellum (Conn). Gramnegative.

Gelatin colonies: Yellow, translucent, smooth, undulate.

Gelatin stab: Villous growth in stab. Crateriform liquefaction

Agar slant: Yellow to orange, glistening, translucent, slightly spreading

May lose power to form pigment. Broth: Turbid, with yellow sediment.

Litmus milk: Unchanged.

Potato: Dark yellow, raised, rough, spreading.

Indole not formed.

Nitrites and ammonia produced from nitrates.

Ammonia produced from peptone. Starch is digested.

Aerobic, facultative Optimum temperature 25°C.

Habitat : Water.

5. Pseudomonas periurida Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., 59, 1913, 516; also McBeth, Soil Sci., 1, 1916, 472; Cellulomonas perlurida Bergey et al., Manual, 1st ed., 1923, 163.)

Rods: 0 4 by 1.0 micron. Motile with one to three polar flagella. Gram-

negative.

Gelatin stab: Liquefaction.

Agar slant: Moderate, flat, faint yellow

Broth: Turbid in 5 days.

Litmus milk: Acid. Peptonization after 16 days.

Potato: Scant yellow growth with bleaching along line of growth.

Indole not formed.

Nitrites not produced from nitrates. Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol. Aerobic, facultative.

Optimum temperature 20°C.

Source: Soil from Virginia, Louisiana and Missouri.

Habitat : Soil.

5a. Pseudomonas perlurida var. sirginiana Kellerman et al. (loc. cil.). Does not grow on potato and liquefics gelatin rapidly.

Source: Soil from Virginia.

6. Pseudomonas Iridescens Stanier. (Jour. Bact , 45, 1911, 542.) From Latin, iridescent.

Rods: 02 to 03 by 1.5 to 7.0 microns, average length 50 to 6.0 microns, occursingly. Non-motile. Gram-negaring tive.

Sea water gelatin stab: Filiform growth. Liquefaction by some strains.

Sa water agar colonies: Concave, 2 to 3 mm in diameter, smooth, glistening, translucent, prle yellow, edge irregular. After 2 to 3 days a marked iridescence Later colonies rough, opaque, bright yellow, sunken central portion with trans-1 constitution.

pale

yellow, iridescent, outseen

Sea water broth: Turbid, light yellow,

Indole not formed.

Nitrites not produced from nitrates Hydrogen sulfide not produced

Catalase positive.

Urcase negative.
Acid from xylose, glucose, galactose, factose, maltose, sucrose and cellulouse
No acid from arabinose. Starch and cellulous are attacked

Acmbie.

Optimum temperature 23°C Minimum 5°C. Maximum 30°C.

Salt range: 0.25 to 6 0 per cent Optimum 1.0 to 4 0 per cent.

Source: Sea water

Habitat: Common along the coast of the North Pacific.

Pseudomonas turcosa (Elimmermann) Migula. (Bacillus turcosa Zimmermann, Brakt, unverer Trink. und Natradeser, Chemnate, £, 1891, 32, Migula, Syst. d. Ilakt. £, 1900, 937, Flaro bacterium turcosum Bergey et al. Man ud., lat. ed., 1922, 111) From M. L. durcosa, turquoise

Rods: 0.5 by 1.05 to 1.52 microns, or curring singly. A short polar flagellum (Migula). Gram-negative

Gelatin colonies. Small, translucent,

Gelstin stati Small, yellow, convex surface growth, with slight brownish that. Liquefaction, with grayish to greenish color in hour-fied portion

Arer slant. Abundant, abstering, arenish to suffer yellow strest.

Broth: Slightly turbid with yellow sediment.

Litmus milk: No coagulation. Yellow sediment.

Potato: Clear chromium yellow growth over entire surface.

Indole is not formed.

Natives not produced from nitrates.

Acid from glucose. Slight action on sucrose

Aerobie, facultative.

Optimum temperature 30°C.

Source Isolated by Tataroll from a well in Dorpat (Die Dorpaten Wasserbakterien, Inaug. Diss., 1891, 52, No. 21).

Habitat Water, sea water.

S Pseudomonas ochracea (Zimmermann) Cheater, (Bacillus ochraceau Zimmermann, Bakt, unserer Trink- und Nutru ässer, Chemnite, J., 1850, 60; Chester, Determantire Bacteriology, 1901, 316; Florobacterium achraceum Bergoy et al., Manual, lat ed., 1923, 110; Chromobacterium ochraceum Topley and Wilson, Prine Bact and Immun, J., 1931, 405) From Greck, ochras, pale yellow.

Rods 0.7 to 0.8 by 1.2 to 4.5 microns, occurring in pairs and longer chains. Slow undulatory motion (Zimmermann). Polar flagella (Lehmann and Neumann, Bakt Dan, 1.4 auf., 2, 1896, 255) Grammerstate.

Gelatin colonies Pale yellou to golden, ochro jellow, shightly mised, with slightly fringed margin, granular

Gelatin stab Vellowish to yellow-gray surface growth Infunddoutdorn inquefaction Pale yellow to other yellow sediment

Arre colonies. Thun, flat, pellowish,

Agar slant: Thin, yellowish-gray to orbitecous growth

Hand Sirktly turind, with pair yel-

latmus milk. Medium becomes slimy; alkalire.

Parato Octor pellor atrest. Indde in formed, Nitrites not produced from nitrates. Hydrogen sulfide is formed. Aerobic, facultative. Optimum temperature 35°C. Source: Chemnitz tap water. Habitat: Water.

9. Pseudomonas cerevisiae Fuhrmann. (Fuhrmann, Cent. f. Bakt., II Abt., 16, 1906, 309; Flavobacterium cerevisiae Bergey et al., Manual, 1st ed., 1923, 111.) From Latin, cerevisia, beer,

Rods: Straight and slightly curved. 0.6 by 1.5 to 2.0 microns, occurring singly and in chains. Motile, possessing tuft, four to six polar flagella. Gram-negative.

Gelatin colonies: Circular, white, slightly contoured, becoming brownishvellow.

Gelatin stab: Slight yellowish growth in stab. No liquefaction.

Agar colonies: Thin, spreading, contoured.

Agar slant: Moist, glistening, thin, pale vellow, spreading, contoured.

Litmus milk · Slow coagulation. Potato: Yellowish-brown, spreading growth.

Indole not formed. Nitrites produced from nitrates.

No gas from glucose. Aerobic, facultative.

Optimum temperature 30°C Source: Isolated from beer. Habitat - Unknown.

Pseudomonas arguta McBeth. (McBeth, Soil Science, 1, 1916, 465; Cellulomonas arguata (sic) Bergey et al., Manual, 1st ed , 1923, 164.) From Latin, argue, to show.

Rods: 0.3 by 0 8 micron. Motile with one or two polar flagella. Gram-negative.

Gelatin stab: Moderate, yellowish growth. No liquefaction in 30 days.

Agar colonies: Circular, slightly convex, soft, grayish-white, granular, entire. Agar slant: Scant, grayish-white growth.

Potato agar slant: Moderate, yellowish, glistening.

Broth: Turbid.

Ammonia cellulose agar: Enzymatic zone 2 to 3 mm in 30 days.

Filter paper broth: Paper is reduced to loose flocculent mass which disintegrates very readily on slight agitation. More rapid decomposition when the broth contains ammonium sulfate, potassium nitrate, peptone or casein as sources of nitrogen.

Litmus milk: Acid, not digested.

Potato: No growth.

Indole not formed. Nitrites produced from nitrates.

Ammonia not produced.

Acid from glucose, maltose, lactose, starch. No acid from glycerol, mannitol or sucrose.

Aerobic, facultative.

Optimum temperature 20°C. Source: Isolated twice from California elina

Habitat : Soil.

11. Pseudomonas subcreta McBeth and Scales. (McBeth and Scales, Bur. Plant Industry, U. S. Dept. Agr., Bul. 266, 1913, 37; Cellulomonas subcreta Bergey et al , Manual, 1st ed., 1923, 164.) From Latin, sub, under, imperfect; creta chalk.

Rods: 0 3 by 1.4 microns. Motile with one to five polar flagella. Gram-negative. Gelatin stab: Filiform growth, no liquefaction.

Cellulose agar: No surface growth. Moderate, generally faint yellow growth

in medium, area of growth sunken. Agar slant: Glistening, smooth, moist, vitreous to faint yellow.

Starch agar : Enzymatic zone 2 to 4 mm.

Broth: No growth.

Litmus milk: No growth. Potato: Growth scanty, concave due to

slight liquefaction, white to faint yellow. Bleached around growth.

Indole not formed.

Trace of nitrites produced from ni-

Ammonia not produced.

Acid from glucose, lactose, maltose,

sucrose and starch. No acid from glycerol or mannitol

Aerobio, facultative

Optimum temperature 20°C Habitat : Soil.

12. Pseudomonas pictorum Gray and Thornton. (Gray and Thornton, Cent. f. Bakt, II Abt., 73, 1928, 89, Ackromobacter pictorum Bergey et al., Manual, 3rd ed., 1930, 217) From Latin, picts, the Piets of Eastern Scotland.

Rods: 0.5 to 0.8 by 1 5 to 50 microns Motile usually with a single polar flagellum. Gram-negative

Gelatin colonies Circular, greenishyellow, convex, smooth, glistening, entire.

Gelatin stab: No liquefaction

Agar colonies: Circular, yellow, convex,

smooth, glistening, entire Agar slant: Filiform, yellow, convex,

smooth, glistening, entire

Broth: Turbid.

Nitrites produced from nitrates

Starch not hydrolyzed

Acid from glucose and maltose

Attacks phenol. Aerobic, facultative. Optimum temperature 25°C

Source: One culture from soil Habitat: Soil

13. Pseudomonas Iacunogenes Goresline. (Jour Bact, 26, 1933, 447) From Latin lacuno, dimple and genero, to produce. Short rods, 0.2 to 0.3 by 1.0 to 1.2

short rods, 0.2 to 0.3 by 10 to 12 microns, with pointed ends, occurring singly or in pairs. Mottle with a single polar flagellum from 2 to 15 microns in length. Gram-negative

Plain gelatin stab No growth

Nutrient gelatin stab. Growth brownish-yellow, half-way down stab, heavier at surface. No liquidaction

Nutrient agar colonies Small, yellow, surface of the agar putted or dimpled After 5 days colonies 5 to 7 mm in diam-

eter, orange-yellow, slightly raised, surrounded by a depression.

Nutrient agar slant: Growth heavy, light orange-yellow, consistency of warm butter, edge entire, slightly ruised Shallow depression formed on each side of streak. Agar softened beneath growth.

Nutrient broth: Turbid in 48 hours, Light orange-yellow pelliele; considerable viscous sediment.

Litmus milk. Alkaline; butter-colored pellicle. Reduction in bottom of tube after 10 days. No curd. No digestion

Potato Growth moderate, orange-yellow, smooth No darkening

Indole not formed.

Nitrites not produced from nitrates. Starch agar plates not hydrolyzed.

Utilizes arabinose, galactose, lactose, fructose, maltose, melezitose, raffinose, starch, vylose, glucose, nannose, sucrose, peetin, rhamnose, salicin and devtina No growth in dulcitol, crythritol, glycerol, sorbitol, manitol or inulin.

Limits of pH: 54 to 100

Temperature relations Optimum 28°C. Good growth at 25°C. Moderate growth at 20° and at 37°C. No growth at 10° and at 42°C.

Facultative anaerobe.

Distinctive characters. Softens agar; considerable change in viscosity of agar due to this digestion; utilization of ammonium sulfate as nitrogen source

Source. Three cultures isolated from an experimental trickling filter receiving creamery wastes.

Habitat Probably widely distributed in nature.

14 Pseudomonas seguis Gorcaine (Jour Bact , 20, 1933, 452) From Latin segue, non-coergetic

Short rods 0 2 to 0 3 by 1 0 to 1 2 mierons, with pointed ends, occurring singly or in pair. Motile with a single polar flagellum. Gram-negative

Plain gelatin stab; No growth.

Nutrient gelatin stab: Growth sellow, half-way clown stab, best at surface No houghstion. Nutrient agar colonies: Very small, light yellow; surface pitted. After 5 days colonies 5 mm in diameter.

Nutrient agar slant: Growth heavy, orange-yellow, consistency of warm butter; edge entire, slightly raised; slight depression formed on each side of growth. Agar softened beneath growth.

Nutrient broth: Turbid in 48 hours. No pellicle or surface growth. Moderate amount of sediment. Old cultures with a yellow ring at surface and occasionally a loose membrane.

Litmus milk: Slightly alkaline after 10 days. No reduction. No surface growth.

Potato · Scant yellow-orange growth. No darkening.

Indole not formed.

Nitrites not produced from nitrates. No II<sub>2</sub>S produced.

Starch not hydrolyzed.

Utilizes arabinose, glucose, galactose, lactose, fructose, maltose, mannose, vylose, sucrose, melezitose and raffinose.

Limits of pH: 58 to 9.0.

Temperature relations: Optimum 28°C. Good growth at 25°C. Moderate growth at 20° and at 37°C. No growth at 10° and at 42°C

Facultative anacrobe.

Distinctive characters: Softens agar; considerable change in viscosity of agar due to this digestion.

Source · Isolated from an experimental trickling filter receiving creamery wastes. Habitat: Probably widely distributed

in nature.

15. Pseudomonas lemonnieri (Lasseur) comb nov (Bacillus lemonnieri Lasseur, Compt. rend Soc Biol. Paris, 74, 1913, 47; Bul. de la Soc. des Sci. de Nancy, 1924; Flavobacterium Lasseuri Bergev et al., Manual, 3rd ed., 1930, 144.) Named for Prof. G. le Monnier, a French scientist.

Rods 05 to 07 by 10 to 2.0 microns, occurring singly and in pairs. Motile

with a single polar flagellum. Gramnegative.

Gelatin colonies (glucose): Circular with blue center, a granular, yellow zone and a peripheral blue zone. Rapid liquefaction with blue crystals.

Gelatin stab : Liquefied.

Agar colonies: Circular, yellowish, lobate margin.

Agar slant: Yellowish streak, smooth, glistening.

listening. Broth: Turbid with thin pellicle.

Litmus milk: After 48 hours the surface of the milk becomes yellow to cream color turning blue. A soft coagulum is formed.

Potato: Raised growth, Prussian blue in color, with variations.

Indole is not formed

Nitrites produced from nitrates. Aerobic, facultative.

Optimum temperature 22° to 25°C. Habitat: Water.

Appendix II:\* The following inadequately described species may belong to the genus Xanthomonas.

Bacterium citri deliciosae Passalacqua. (Rev. Pat. Veg., 24, 1934, 27.) Isolated from Citrus sp.

Bacterium malvacearum var. barbadense Evelyn. (Ann. Rept. Agric. Barbados for 1926-27, 1928, 15.) Isolated from cotton.

Pseudomonas amaranti (sic) Smith. (U. S. Dept. Agr., Div. Veg. Phys. and Path. Bull., 28, 1901, 153; Bacterium amaranthi Smith, Bact. in Relation to Plant Dis. 5, 1914, 148; Phytomonas amaranthi Bergey et sl., Manual, 1st ed., 1923, 180 Isolated from diseased amaranthus. Growth in culture similar to Xanthomonas campestris and Xanthomonas hyacinthi.

Pseudomonas alutacea Migula. (Ledergelber Bacillus, Tataroff, Die Dorpater Wasserbakterien, Inaug. Diss., Dorpat,

Prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1943.

1891, 61; Migula, Syst. d. Bakt., 2, 1900, 936) Isolated from water.

Pseudomonas graveolans Migula (Bacullus aquathlis graveolens Tataroff, Die Dorpater Wasserbakterien, Inaug Dies, Dorpat, 1801, 48; Migula, Syst. d. Bakt., 2, 1900, 931.) Isolated from water Not Pseudomonas graveolens Levine and Anderson (Jour. Baet., 28, 1932, 343) isolated from musty cegs, and by Olsen and Hammer (Iowa State Coll. Jour. Sci., 9, 1931, 125) from milk.

Pseudomonas resinacea Migula. (Hartfarbener Bacillus, Tataroff, Die Dotpater Wasserbakterien, Inaug. Diss., Dorpat, 1891, 64; Migula, Syst. d. Bakt., 2, 1900, 935 ) Isolated from water.

2, 1200, 933 / 1801ated from water.

Xanthomonas taraxac: Niederhauser
(Phytopath., 53, 1943, 961.) Pathogenic on Russian dandelion (Taraxacum kol.-saghz)

## Genus III. Methanomonas Orla-Jensen \* (Cent f. Bakt., II Abt., 22, 1909, 311.)

Cells monotrichous, capable of obtaining energy from oxidation of methane to CO, and water,

The type species is Methanomonas methanica (Söhngen) Orla-Jenson,

Methanomonas methanica (Sohngen) Orla-Jensen. (Bacillus methanicus Sohngen, Cent. f. Bakt, II Abt, 16, 1906, 513; Orla-Jensen, Cent. f. Bakt, II Abt., 22, 1909, 311) From methane

Short took to 5 to 0 8 by 2 0 to 30 micros, motile in young cultures by means of a single flagelium. In older cultures acrity spherical, Can be culturated in an atmosphere composed of one part CHI, and two parts air on washed agar containing the necessary inorganic salts. The growth is modharmous

At the end of two weeks, the organisms changed an atmosphere containing 225 ml. CH<sub>4</sub> and 321 ml. O<sub>4</sub> to the following

CH.			0 ml.
CO.			78 ml.
O,	•		172 ml.

In addition, 21 ml. CO, was dissolved in the liquid.

Habitat Presumably widely distrib-

# Genus IV Acetobacter Beyerinek † (Proc Kon Akad v. Wetcuschapp, Ameterdam, 2, 1900, 495.)

Actionates acet. first appeared (Kral's Sammlung v. Malroorg., Prague, 1898, 4) as a syn nym of Bacterium aceti Hansen. Beijernick (Ioc. et ) mentions Acetobacter acet, in control of a later paper. The genus anime Acetobacter was accepted by Pulmanan Openheff Bot Centralbi, Orig. 19, 1905, 8) and others. From Latin, acetum, vinclar, bactum, nod

Synonyms 7 Ulsina Kütsing, Alzae aquae duleis, etc., 11th decade, 1877; Myco-derna Thombson, Ann a Chem u Pharmacie, 83, 1825, 263; Pumbisa Nargeli, Bericht über die Verhandlungen der bot Section der 23 Versammlung deutsehen Natur-dorscher, und Arster Bot Zig, 1857, 700, Bacterum Lanzi, N. Giora, bot, ital., 1876, 237; Torula Baccardo, Att 05 ev Pen Trent, 5, 1878, 315; Bacteropris (in part)Trevisus, Atti Acead Fisio-Medico-Statistica Milano, Ser 4, 5, 1853, 103; Micrococcus Maggi, Jour. Microg, 10, 1856, Bacillus Schroeter, Kryptogamen Flora von Schleisen, 5, 1, 1856, 161; Termobacterum Zeidler, Cent 1 Bakt, 11 Abt., 2, 1850, 733. Accidoze.

Prepared by Prof D II Bergey, Philadelphia, Pennsylvania, December, 1922.
Revised by Dr C D Kelly, McGill Univ., Montreil, P. Q., Canada, July, 1938;
Jurther revision by Dr. Reese H. Vaughn, Univ. of California, Berkeley, California
June, 1913.

terium Ludwig, in abstract of Hoyer's Inaug. Diss., Cent. f. Bakt., II Abt., 4, 1898, 867; Acetimonas Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 312.

In addition, the sub-generic names Euacetobacter and Acetogluconobacter have been proposed by Asai, Jour Agr. Soc. Japan, 11, 1935, 502. The genus Gluconobacter and the sub-genera Eugluconobacter and Gluconoacetobacter Asai (loc. cit.) may be synonyms in whole or in part.

Individual celle ellipsoidal to long and rod-shaped, occurring singly, in pairs, or in short or long chains. Motile with polar flagella, or non-motile. Involution forms may be spherical, clongated, filamentous, club-shaped, swollen, curved or even branched. Young cells Gram-negative; old cells often Gram-variable. Obligate acrobes; as a rule strongly catalase positive, sometimes weakly so. Oxidize various organic compounds to organic acids and other oxidation products which may undergo further oxidation. Common oxidation products include acetic acid from ethyl alcohol, gluconic and sometimes ketegluconic neid from glucose, dihydroxyacoton from glycerol, sorbose from sorbitol, etc. Nutritional requirements vary from simple to complex. Development generally best in yeast infusion or yeast autolysate media with added ethyl alcohol or other oxidizable substrate. Optimum temperature variable with the species. Widely distributed in nature where they are particularly abundant in plant materials undergoing alcoholic fermentation; of importance to man for their role in the completion of the carbon cycle and for the production of vinegar.

The type species is Acetobacter aceti (Kutzing) Beijerinck.

#### Key to species of genus Acetobacter.

- I. Oxidize acetic acid to carbon dioxide and water.
  - A. Capable of utilizing ammonium salts as a sole source of nitrogen (Hoyer's solution) \*
    - 1. Acetobacter aceti.
  - B Do not utilize ammonium salts as a sole source of nitrogen.\*
    - Forms a thick, zooglocal, cellulose membrane on the surface of liquid media
      - 2. Acetobacter xylinum.
    - Do not form a thick, zooglocal membrane on the surface of liquid media.
      - 3. Acctobacter rancens.
      - 3a. Acetobacter pasteurianum.
      - 3b. Acetobacter kuetzingianum.
- II. Do not exidize acetic acid.
  - A. Form pigments in glucose media-
    - 1. Dark brown to blackish mement.
      - 4. Acetobacter melanogenum.
    - Pink to rose pigment.
- 5. Acetobacter roseum.
- B. Do not form pigments.
  - 1. Optimum temperature 30° to 35°C.
  - 6. Acetobacter suboxydans.
  - Optimum temperature 20° to 25°C.
    - 7. Acetobacter oxydans.

<sup>\*</sup> It is not known with certainty whether Acetobacter pasteurianum and Acetobacter kueltingianum are capable of using inorganic nitrogen as a sole source of nitrogen for growth. However, since these two species are among those first described it is advisable to retain them for the present. See Acetobacter rancens Beijerinek.

1. Acetobacter aceti (Kützing) Beijerinck. (Ulring acets Kützung, Algae aquae dulcis etc. 11th decade, 1837, Mycoderma acets Thompson, Ann d Chem. u. Pharmacie, 83, 1852, 89, Umbina aceti Naegeli, Bericht über die Verhandlingen der bot. Section der 33 Versammlung deutscher Naturforscher und Arster, Bot. Zig , 1857, 700, Bacterium aceti Lanzi, N Giorn bot ital 1876, 257; Torula aceti Sacrardo, Atta See Ven. Trent., 5, 1878, 315, Bacteriopsis greti Trevisan, Atti della Accademia Lisio-Medico-Statistica in Milano, Ser 1, 3, 1855, 103; Microroccus aceli Maggi, Jour, Microg. 10, 1856, Bacillus acets Schmeter, Kryptogamen Flora von Schle sien, 3, 1, 1886, 161, Bacillus acetieus Plügge, Die Mikmorganismen, 186, 311, Beijeriack, Kral's Sammlung v. Mikra org , Prague, 1898, 7, Beijerinek, Proc Kon, Akad, v. Wetensch , Amsterdam 2, 190, 497; Bacterium hansenianum Chester, Man. Determ Bact , 1901, 126 From Latin acetum, vinegar

Role: 0 1 to 0 5 by 1 9 to 20 michins. occurring singly and in long chains, frequently showing large club shared forms Strin velley with jodne solution Motility variable. Motile cells process a single polar flagellum (Vaughn, Jour Bact , 40, 1943, 3941 Forms large. sluty colours on heer goldten containing If per rent merine

Forms show pellicie on flux i med a or ting or turbulity with at reflicie

Aril Inm glucore, ethal airclaft proplated danteland Acad Hon Antonine, fruction, galaction a three s tenne, maltine, lartiue, sie is se, ilea thin, stately, glangers smalin, mould almitel, jumpings | alote 1 to 151 almitel entrared atached, arrest at a til glacer t. erythered, mannered, district at larcest alityds Bleenslerg, De digtert 14 \* 2007 . J. 34 N. 1873

Data dase et rectere Africado s detier power en ling ter 1 and emplete enitals malfactuatestesses on marets of stately straig trace terreter to the gen salts as a sole source of nitregen (Hoyer, Inaug. Dies, Leiden, 1898, 43; Beiferinck, Cent & Bakt . II Abt . 4. 1595, 215); growth and oxidative activity in association with fermenting yearls (Vaughn, Jour. Bact , 50, 1938, 300)

Optimum temperature 30°C Growth occurs between 10° and 42°C

Habitat: Vinegar; souring fruits, vigetables and beverages.

2 Acetobacter avlinum (Brown) Holland (Bacterium rylinum Brown, Jour Chem Soc. London, 42, 186, 439; Holland, Jour Hact . 5, 1939, 216; Bacillus ralinus Holland, ibid. 221) From Gr Tilinus, woulden (in reference to the cellulose in the membrane)

Rosls, about 2 microns long, occurring singly and in claims. The cells have a elimy envelope which gives the collulose reaction

I film forms on the surface of liquids, This film becomes cartilizenous and falls to the bettom This reschool film forms on all liquid media in which growth occurs, the nature of the medium influence a the thickness of the film which may san from I to CO millimeters

X ray pattern studies made by Khonsine, Clampetier and Satra (Compt. rend Aral Ser Pane, 191, 1912, 38) and by Eursta and Hildert (Can Jour Research, 19, 1931 (To) love at own that the criticise contributed in the Frent tares free of his Acet bacter ratio in 18 1 feets only with out to religious

ted from glurone, ettal sleatel, provalated of and classic No arrillers pest come, Injetone, palartium, ciabium, I river, the over destroy grant prestat stately, a gree of alone I, torret alone of se to tall alout I good afrond to process set on I arrive to a therefore, Dr. desert forest, f. Po. 10)

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Is at a office of courter Thing mit its m et it it, feattere, geglent eeft buie man to serve the a street to the die in die eine genet de geit

Habitat: Vinegar; souring fruits, vegetables and beverages.

3. Acetobacter rancens Beijerinck. (Bacterium rancens Beijerinck, Cent. f. Bakt., II Abt., 4, 1893, 211; Beijerinck, Kral's Sammlung v. Microorg., Prague, 1898, 4.) From L. rancens, being rancid

Beijerinck (loc. cit.) in a footnote stated that "two of the many varieties of B. rancens have been described by Henneberg under the names of B. oxydans and B. acctosum. Hansen erroneously called this species B accti as did Brown. Neither Hansen nor Brown knew B. accti Pasteur." No further morphological description is given.

The following description is taken in part from a study of a culture of Aceto-bacter rancens received from Kluyver (Vaughn).

Rods with the usual morphological appearance of cultures of acete acid bacteria Gram negative Motility variable, Motile cells possess a single polar flagellum (Vaughn, Jour Bact., 49, 1913, 394). Involution forms commonly appear as filaments and enlarged cells

Wort agar slant: Growth abundant, butyrous, pale-buff in color in one week,

Yeast infusion, glucose, calcium carbonate slant: Growth abundant, butyrous and cream-colored in one week.

With petri dish cultures well isolated colonies are large, smooth and butyrous on either medium.

Broth cultures containing peptone or yeast infusion form a mucilaginous, slimy pellicle. Beijerinek (loc. cit.) called this polysaccharide pellicle, cellulose-like and intimated that the mucilaginous material in the pellicle was somewhat different from that produced by Acctobacter xylinum. The pellicle material stained blue when treated with iodine and hydroiodic acid.

Acid from glucose, ethyl alcohol, propyl alcohol, butyl alcohol, glycol, adonitol, mannitol and sorbitol. No acid from numerous other compounds tested. Distinctive character: Production of a thin, mucilaginous, slimy, polysaccharide membrane on the surface of liquids as compared with the thick, true cellulose membrane of Accibacter zylirum grown under the same conditions. Bejierinek (loc. cit.) reported the production of a cellulose-like membrane with some cultures of Accibacter rancens.

Source: Isolated from shavings in the quick vincear process.

Habitat: Found in fermented grain mash, malt beverages, mother of vinegar. Beijerinek (Cent. f. Bakt., II Abt., 4, 1803, 211) thought that the next two species were hardly more than varieties of Actibacter reneems.

3a. Acetobacter pasteurianum (Hansen) Beijerinek. (Mycoderma pasteurianum Hansen, Compt. rend. d. Trav. d. Lab. d. Carlsberg, I, 1879, 99; Bacterium pasteurianum Zopf, Dio Spaltpiller, 2 Aufl., 1884, 49; Beijerinek, Kral's Sammlung v. Mieroörg., Prague, 1898, 7.) Named for Pasteur, the French chemist and bacteriologist.

Rods: 0.4 to 0.8 by 1.0 micron, occurring singly and in chains, at times showing thick, club-shaped forms. Motility variable. Motile cells possess a single polar flagellum (Vaughn, Jour. Dact., 46, 1913, 391). Stains blue with iodine.

Wort gelatin colonies: Small, circular, entire, gray, slimy.

Forms a dry, wrinkled folded pellicle on double beer with one per cent alcobol. Meat infusion gelatin: Widespread, later resette form, toothed.

Acid from glucose, ethyl alcohol, propyl alcohol and glycol. No acid Irom arabinose, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinose, dettrin, starch, glycogen, inulin, methyl alcohol, isopropyl alcohol, butyl alcohol, isopropyl alcohol, butyl alcohol, erythritol, mannitol, dulcitol and actal-dehyde (Henneberg, Die deutsch. Essisind. £. 1898, 147).

Aerobic.

Optimum temperature 30°C. Growth occurs between 5° and 42°C.

Habitat: Vinegar: beer and beer wort

3b. Acclobacter kuetzingianum (Hansen) Bergey et al (Bacterium kuetzingianum Hansen, Compt. rend. d. Trav d Lab. d. Carlsberg, 3, 1894, 191; Bergey et al., Manual, 1st ed., 1923, 35) Named for Kuetzing, the German botanist

Short, thick rods, occurring singly Rarely forming chains of notable length Capsule stained blue with iodine and with potassium iodide. Non-motile

Double beer gelatin colonies · Small, entire, with vermiform surface

Wort gelatin colonies: Small, entire, with surface free of wrinkles

Double beer: Forms a rather thick, folded pellicle. Distinguished from Acctobacter acets in showing heavier growth above the surface of the media

Acid from glucose, ethyl alcohol, propyl alcohol and glycol. No acid from arabinose, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinose, devtrin, starch, glycogen, nulin, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerol, erythritol, mannitol, dulettol and acetal-dehyde (Henneberg, Die deutsch Essiguad, 2, 1803, 147).

Aerobic.

Optimum temperature 31°C, maximum 42°C, minimum 6 to 7°C

Habitat: Beer. Found in double beer

4. Acetobacter melanogenum Berjerinek. (Cent. f Baht., II Abt., 29, 1911, 175) From Greek melas (melan), bluck; genes, producing.

Rods. Non-motile or motile. Motile cells possess a single polar flagellum (Vaughn, Jour. Bact, 46, 1913, 391)

Gelatin: Apparent Inquefaction probbly caused by acid, not an enzyme When held on artificial media for some time, the power of Inquefying gelatin is lost, probably due to a slower production of acid. Deep brown pigment produced; gelatin becomes insoluble in boiling water and in trypsin solution,

Beer- or wort-gelatin plates: Characteristic dark brown, wide-spreading, diffuse areas.

Tap water-agar-glucose-peptone-potassium phosphate-iron citrate-chalk medium: In 24 hours at 30°C, black, spreading, diffuse areas.

Utilizes peptone as a source of nitrogen Produces the pigment from peptone only if maltose or glucose is present as a source of carbon. When grown in glucose-peptone broth with CaCO, at 25° to 30°C, black pigment is produced after several weeks, and the carbonate is changed to calcium gluconate.

Pigment: The pigment causing the brown coloration is an aromatic substance which is blackened by iron salts. Reduces alkaline solutions of silver and mercury, blackening them

Oxidizes mannitol and sorbitol to fructose and sorbose. Does not attack sucrose and fructose. Much gluconic acid is produced. Acid from glucose and maltose. Acetic acid produced from alcohol

Distinctive character: The formation of dark brown to black pigment in media containing a suitable substrate; particularly glucose.

Source Isolated from beer.

Habitat: Causes light-colored beer to become darker brown. It is a very strong beer-vinegar bacterium. Also found in souring fruits

5. Acetobacter roseum Vaughn. (Bacterium hoshiçalı var. rosca Takahashı and Asaı, Cent f Bakt, 11 Abt., 52, 1930, 390; Acetobacter hoshiqati Bergey et al., Manual, 4th ed., 1931, 39, Vaughn, Wallerstein Lab. Communications, 6, No. 11, 1912, 20) From Latin, rosa, rose.

Rods: 07 to 09 by 1.5 to 1.8 microns, generally occurring singly, at most in pairs, often in chains. Non-motile. Pelliele on fluid media yields no starch or cellulose reaction.

Koji (a mixture of rice and mold spores used to start fermentation of Japanese bread and saké) extract agar colonies: Small, granular, circular, glistening, umbonate, becoming brownish.

Wort agar colonies: Circular, milkywhite, becoming brownish in center and vellowish at periphery.

Glucose saké agar: Circular, milkywhite, granular, umbonate, entire,

Hoshicaki (dried persimmons) extract agar: Circular, milky-white, granular, becoming yellowish-brown in the center and grayish-white at the periphery.

Koji extract agar streak: Gravishwhite, glistening with ciliate margin, becoming purple brown to brown.

Koji extract: Turbid with thin film. ascending on wall of tube.

Bouillon: Turbid with ring formation. Yeast infusion glucose agar: Colonics similar to those on wort ngar.

Yeast infusion glucose broth: Turbid with thin, ascending film.

Red color produced on saké wort agar and all media containing calcium carbonate

Acid from glucose, fructose, galactose, arabinose, glycerol, mannitol, ethyl and propyl alcohol. No acid from maltose, sucrose, lactose, raffinose, dextrin, starch, inulin, sorbitol, glycogen, isodulcitol and methyl alcohol

Forms gluconic acid from glucose,

Aerobic.

Optimum temperatures 30° to 35°C; maximum 40° to 41°C, minimum 10° to 15°C.

Thermal death point 50°C for 5 minutes

Distinctive character: The formation of a rose to red pigment in suitable media; particularly those containing glucose and calcium carbonate.

Source Isolated from fermenting mash of dried persimmons (hoshigakı), and souring figs and dates.

Note: Vaughn, Wallerstein Lab Communications, 5, No. 14, 1912, 20, has proposed the name Acetobacter roseum to replace the name Acetobacter hoshigali

As originally described, this organism was given the name Bacterium hoshioaki var. rosea by Takahashi and Asai (loc. cit.) without the authors having first named and described the species Bacterium hoshigali. The Japanese word "hoshigaki" has been used in a confusing manner vir. Takahashi and Asai, loc. cit. (Bacterium industrium var. hoshigaki) and Takahashi and Assi-Jour. Agr. Chem. Soc. Japan. 9, 1933, 351 and Cent. f. Bakt., II Abt., 87, 1933, 385 (Bacterium hoshigali var. alucuronicum I, II and III). None of these Japanese names are in the form of true binomists.

6. Acetobacter suboxydans Kluvver and de Leeuw. (Paper read at the convention of the Dutch Society of Microbiology, Utrecht, December, 1923, see Tiidschrift v. Vergelijkende Geneeskunde, 10, Aft. 2-3, 1921.) From L. sub, under, less; Gr. oxys, sharp, acid; dans, giving, i.e less acid giving; less oxidizing. Short rods: Occurring singly or in

chains Non-motile. Morphologically like Acetobacter rancens. Forms very thin, hardly visible pellicle

on fluid media.

Wort agar colonies: Very small, circular, slightly yellow.

Acid from ethyl alcohol, propyl alcohol, glycol, glucose, glycerol and sorbitol. Optimum temperature 30°C.

Distinctive character: Partial oxidation of substrates as indicated by the formation of calcium 5-keto gluconate erystals on the surface of agar slants containing glucose and calcium carbonate.

Source: Isolated from spoiled beer. Habitat : Beer.

Acetobacter oxydans (Henneberg) Bergey et al. (Bacterium oxydans Henneberg, Cent. f. Bakt , II Abt , 5, 1897, 223; Bacillus oxydans Migula, Syst. d. Bakt., 2, 1900, 800; Bergey et al., Manual, 1st ed , 1923, 36.) From Gr. oxys, sharp,

acid: dans, giving, Rods 08 to 12 by 24 to 2.7 microns,

occurring singly and in chains. Motile

cells possess a single polar flagellum (Vaughn, Jour. Bact., 46, 1943, 394) The chains show bud-like swellings

Gelatin colonies: Circular, becoming irregular in shape with peculiar ramifica-

Acid from arabinose, fructose, glucose, galactose, sucrose, maltose, raffinose, dextrin, ethyl alcohol, propyl alcohol, erythritol, mannitol, glycol and glycerol No acid from sorbose, lactose, starch, glycogen, inulin, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, dulcitol and acetaldehyde (Henneberg, Die deutsch Essigind., 2, 1808, 147).

Aerobie

Optimum temperature 15° to 21°C Distinctive characters Low optimum

temperature for growth and oxidation of substrates; and the ability to oxidize a large number of substrates

Habitat : Beer.

Appendix: The following species have been described, but until more comparative studies have been made, no change in nomenclature is recommended or advisable

1. Acetobacter zeidlerl Beijerinck (Termobactersum acets Zeidler, Cent f Bakt., II Abt , 2, 1896, 739, Bacterium zeidlers Beijerinch. Acetobacter zeidlers Beijerinek, Kral's Sammlung v. Mikroorg , Prague, 1899, 7, Bacillus zeidlers Migula, Syst d Bakt , 2, 1900, 801, Acclobacter lindners Bergey et al , Manual, 1st ed., 1923, 36) Named for A. Zeidler, who first isolated this species

Rods, occurring singly and in chains, showing large sausage-shaped involution forms. Motile with a single polar fligellum (Zeidler, Cent f Bakt, II Abt , 4, 1503, 669).

Wort gelatin Small, circular, slightly granular, yellowish-brown, entire colonies. No liquefaction

Dirty, yellowish-brown pellicle on liquid media.

Wort gelatin slant : Strongly glistening,

transparent, whitish in center, smooth, very weakly liquefied

Potato: Very scant grouth

Acid from glucose, ethyl alcohol, propyl alcohol and glycol No acid from arabinose, fructose, galactose, maltose, lactose, raffinose, dextrin, glycogen methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerol, mannitol and acetaldehyde (Henneberg, Die deutsch Essigind, 2. 1898, 147).

Aerobic, facultative.

Optimum temperature 25°C. Habitat: Beer wort.

2 Acetobacter acetosum (Henneberg) Bergev et al. (Bactersum acctosum Henneberg, Cent f Bakt, II Abt, 3, 1897, 223, Bergey et al., Manual, 1st ed., 1923. 36) From Latin, acetum, vinegar.

Rods . 0 4 to 0 8 by 1 0 micron, occurring singly and in chains Non-motile. Stains yellow with iodine.

On beer, yeast water and glucose solutions a firm, coherent, uniform, smooth, white film that becomes folded (Henneberg, Garungsbakt., 2, 1926, 201).

Acid from glucose, galactose, ethyl alcohol, and propyl alcohol. No acid from arabinose, fructose, sorbose, sucrose, maltose, lactose, raffinose, dextrin. starch, glycogen, inulin, methyl alcohol, isonropyl alcohol, butsl alcohol, isobutyl alcohol, amyl alcohol, glycerol, erythritol, mannitol, dulcitol and acctaldehyde (Henneberg, Die deutsch Essigmd . 2, 1938, 147).

Ontimum temperature 28°C, maximum 36°C, minimum 8°C (Henneberg, Cent. f. Bakt , II Abt., 4, 1898, 14).

Habitat: Beer.

3 Acetobacter ascendens (Henneberg) Bergey et al. (Bacterium ascendens Henneberg, Zeitschr, f. deutsche Essigind., Berlin, No. 10 to 23, 1898, 145, also see Cent. f. Bakt., II Abt . 4, 1898. 933, Bergey et al., Manual, 1st ed., 1923, 37.) From Latin, ascendo, pp accendens, accending.

Rods, occurring singly, rarely in chains.

Non-motile. Do not give the cellulose reaction with iodine solution.

Glucose gelatin colonies: Dry, white, with white area surrounding the colony. Fluid cultures have a tough pellicle

rising on the wall of the flask. Acid from ethyl alcohol, propyl alcohol and glycol. No acid from arabinose, fructose, glucose, galactose, sucrose, maltose, lactose, raffinose, dextrin, starch, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerin, mannitol and acetaldehyde (Henneberg, Die deutsch. Essigind., 2, 1898, 147).

Aerobic.

Optimum temperature 31°C.

Habitat: Isolated from vinegar and from red wine.

4. Acetobacter plicatum Fuhrmann. (Beihefte z. bot. Centralbl., Orig., 19, 1905, 8 ) Description given in Cent. f. Bakt., II Abt , 15, 1906, 377. From plicatus, folded.

Rods: 0 55 to 0 7 by 0.75 to 0.9 microns when grown on agar at 28° to 30°C. Young streak cultures 0.4 to 0.6 by 1.4 to 1.6 microns with homogeneous staining when grown on beef-extract-gelatin at 22°C, 05 by 1.5 to 1.7 microns with uneven staining (polar) when grown on wine gelatin. At about 40°C the organisms form swollen and greatly elongated forms. Non-motile

Agar slant · Pale yellowish, translucent growth.

Alcohol-free beer with glucese and sucrose. Turbid with thick pellicles.

Potato: Growth limited. Ferments alcohol to form acetic acid.

Optimum temperature 28° to 30°C.

. Habitat : Wine.

5. Acetobacter acetigenum (Henneberg) Bergey et al. (Bacterium acetigenum Henneberg, Cent f. Bakt, II Abt., 4, 1898, 14; Bacillus aceligenum Migula, Syst. d. Bakt., 2, 1900, 801; Bergey et al., Manual, 1st ed., 1923, 35.) From Latin, producing vinegar.

Rods, occurring singly and in pairs. 0.8 to 1.2 by 1.2 to 1.4 microns. Motile. Cells give a cellulose reaction with H-SO. and iodine.

Glucose gelatin colonies: Raised, grayish, slimy.

Fluid cultures show a tough, slimy pellicle.

Acid from glucose, ethyl alcohol, propyl alcohol and glycol. No acid from arabinose, fructose, galactose, sorbose, sucrose, maltose, lactose, raffinose, dextrin, starch, glycogen, inulin, methyl alcohol, isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol, glycerol, erythritol, mannitol, dulcitol and acetaldehyde (Henneberg, Die deutsch, Essigind., 2, 1898, 147).

Aembic.

Optimum temperature 33°C. Thermal death point 43° to 45°C for 5 minutes.

Habitat: Vinegar.

6. Acetobacter industrium (Henneberg) Bergey et al. (Bacterium industrium Henneberg, Zeitschr. f. deutsche Essigindustrie, Berlin, 1898; Cent. f. Bakt., II Abt., 4, 1898, 933; Bacillus industrius Migula, Syst. d. Bakt., 2, 1900, 801; Bergey et al., Manual, 1st cd., 1923. 36.) From Latin industrius, diligent.

Rods 0.3 to 0.8 by 2.4 to 20 microns, occurring singly and in chains No distinct color produced with iodine. Motile.

Forms pellicle on fluid culture media. Acid from arabinose, fructose, glucose, galactose, sucrose, maltose, lactose, raffinose, starch, dextrin, ethyl alcohol, propyl alcohol, glycol, glycerol and mannitol. No acid from isopropyl alcohol, butyl alcohol, isobutyl alcohol, amyl alcohol and acetaldehyde (Henneberg, Die deutsch. Essigind., 2, 1898, 147).

Aerobic.

Optimum temperature 23°C. Mavi mum 35°C. Minimum 8°C.

Habitat: Beer wort.

 Bacterium schuezenbachii Henneberg. (Die deutsche Essignid, No 11-18, 1906; also Cent f Bakt, II Abt, 17, 1906, 790.) Named for Schüzenbach, the inventor of the German quick vinegar process.

Rods: 0 3 to 0.4 by 1 0 to 3.6 merons, occurring singly, in pairs and chains. The cells are round, oval or elongasted, not infrequently sickle-shaped or irregularly bent with rounded or pointed ends. Not stained with iodine. Non-motile

Wort gelatin colonics Round, shiny, transparent with yellowish brown centers

A non-coherent film produced on the surface of liquid media

Acid from arabinose, fructose, glucose, galactose, maltose, lactose, devtrin, ethyl alcohol, propyl alcohol, glycerol and erythritol. Small amount of send from sucrose and raffinose No acid from mannitol (Henneberg, Handbuch d Garungsbakt., 2, 1925, 239).

Temperature relations. Optimum 25° to 27.6°C. Scant growth at 34° to 35°C and 13° to 15°C. No growth at 37° and 75°C.

Source: Isolated from vinegar in the quick vinegar process

Habitat. Produces acetic acid in quick vinegar process

Bacterium xylinoides Henneberg
 (Die deutsche Essigind., No. 11 to 18, 1906; also Cent. f. Bakt., II Abt., 17, 1906, 791.)

Rods: 0 s to 0.8 microns (round cells) and 0 5 to 1.2 microns (long forms), occurring singly, in pairs or chains, cells round and as short and long rods. The thick membrane like that produced by Acetobacter xylinum gives the reaction for cellulose with iodine and sulfuric acid, but the thin membrane does not

Wort gelatin. Colonies are produced like drops of water, often with light brown kernels in the center.

Wort gelatin streak. Growth transparent at first, later whitish Three types of membrane on fluid media are formed by this species and all three may even be found on a culture at one time. A thin, firm, coherent membrane like that of Bacterium orleanness may be formed or one that is voluninous, scumilke (like coagulated egg-white), coherent, somewhat slimy and finally thick like that of Bacterium xylinum. Also a membrane may be formed that is intermediate in type.

Acid from arabinose, glucose, galactose, sucrose, maltose, ethyl alcohol, propyl alcohol, glycerol and erythritol. Small amount of acid from fructose and mannitol.

Temperature relations Optimum 28°C. Slight growth at 14°C No growth at 6°C

Source. Isolated from wine vinegar from the Rhine and other sections.

Habitat: Found in vinegar made by the Orleans method

9 Bacterium orleanense Henneberg. (Die deutsche Essignd, No. 11-18, 1906; also Cent. f Bakt, 11 Abt., 17, 1906, 792.) Latinized, of Orleans.

Rods · 0.4 to 0.5 by 1 2 to 2.1 microns, occurring singly or in chains. The cells are round, elongated or as involution forms, with atraight or curved cells appearing Not stained with rodine Non-motile.

Wort gelatin. Colonics stregular in form, whitish in color, about 1 mm. in diameter in 2 days

Wort gelatin streak: Growth often glimy, transparent, liquid mass with vellowish-brown sediment.

Wort agar streak: Some strains form isolated, most, elimy, transparent colonies and on the water of condensation isolated whitish colonies are formed Other strains form a coherent, transparent coating with a light brown precipitate later and individual, distinct, round colonies of the same color.

Characteristic of this species is the firm coherent film on the surface of liquid media. Acid from arabinose, glucose, galactose, maltose, lactose, raffinose, devtrin, ethyl alcohol, propyl alcohol, glycerol, erythritol and mannitol. Small amount of acid from fructose and sucrose (Henneberg, Handbuch d. Garungsbakt., 2, 1926, 239).

Temperature relations: Optimum 20° to 30°C. Slight growth at 35° to 36°C and 14° to 15°C. No growth at 39° and at 7° to 8°C.

Source: Isolated from vinegar in the quick vinegar process.

Habitat: Can be used both in the quick or German process and the Orleans method of making vinegar.

10. Bacterium vini acetati Henneberg. (Die deutsche Essigind, No. 11-18, 1906; also Cent. f Bakt., II Abt., 17, 1906, 797) From Latin vinum, wine and acetum, vincear.

Rods: 0 3 to 0 8 by 0.8 to 2.0 microns, occurring singly, in pairs and sometimes as short chains of three; cell round, oval or slightly clongated, and rarely moderntely long forms. Streptococcus-like cells are found on older agar cultures and spindle forms in beer gelatin with 10 per cent sucrose.

cent sucrose.

Wort gelatin: Round, moist, shiny, transparent colonies with whitish sediment in the center.

The film on liquid media is not strongly coherent and the liquid is cloudy.

Acid from arabinose, fructose, glucose, galactose, sucrose, maltose, raffinose, dextrin, ethyl alcohol, propyl alcohol, glycerol and crythritol. No acid from lactose (Henneberg, Handbuch d. Gärungsbakt., §, 1925, 239).

Optimum temperature 28° to 33°C

Source · Wine vinegar.

Habitat: Found in vinegar made by the
Orleans method for wine vinegar.

11. Bacterium curvum Henneberg. (Die deutsche Essigind, No 11-18, 1906; also Cent. f. Bakt., II Abt., 17, 1906, 791) From Latin, curvus, bent.

Rods: 0.4 to 0 5 by 2 0 to 2.4 microns,

occurring singly or in pairs, cells usually oval or clongated, not infrequently sickleshaped, with rounded or pointed ends Not stained with iodine solution. Nonmotile.

Wort gelatin: Transparent, round colonies with raised center and edge, frequently whitish and dry.

A non-coherent scanty pellicle is formed on the surface of liquid media which sinks readily and the liquid is quite turbid.

Forms round white islands on the surface of wort with 3 per cent alcohol.

In old cultures on beer are to be found numerous smooth light brown raised colonies about 1 mm in diameter on the uniform transparent base of the surface membrane.

Acid from arabinose, glucose, raffinose, dectrin, ethyl alcohol, propyl alcohol, glycerol and erythritol. Small amount of acid from fructose, galactose and mannitol. No acid from sucrose, maltose and lactose (Henneberg, Handbuch d. Gärungsbakt., 2, 1925, 233).

Temperature relations: Optimum 25° to 30°C. Scant growth at 16° to 17°C. No growth at 7° to 8°C. Growth at 35°C. No growth at 30°C.

Source: Isolated from vinegar in the quick vinegar process.

Habitat: Produces acetic acid in the

12. Acetobacter viscosum Shimwell (Bacterium aceti viscosum Day and Baker, Cent. f. Bakt., II Abt., \$6, 1913, 433; Bacıllus aceti viscosum Day and Baker, tbid., 437; Also see Baker, Day and Hulton, Jour. Inst. Brewing, —, 1912, 651; Shimwell, Jour. Inst. Brewing, 42 (N. S. \$2), 1936, 586.) From Latin, viscous or slimy.

Rods: 0.4 by 1.2 microns which produce ropiness in beer. No capsules observed. Non-motile as a rule. Weakly Grampositive

Source: From ropy beer.

13 Acetobacter capsulatum Shimwell. (Jour. Inst. Brewing, 42 (N. S. 32), 1936, 585.) From Latin, capsulated.

Coccoid rods, 0 8 to 1 0 micron in malt extract media. 0 6 to 1 5 microns in other media. Produce ropiness in beer. Capsulated. Motile, Gram-negative.

Source: From ropy beer.

14 Acetobacter gluconicum (Hermann).\* (Bacterium gluconicum Hermann, Biochem. Zeit , 192, 1928, 198, also see Hermann, Biochem. Zeit , 205, 1929, 297 and Hermann and Neuschul, Biochem. Zeit., 233, 1931, 129)

It is unfortunate that an organism so well described must be placed with other species of uncertain standing ever, this organism is so closely related to the other organisms described in the literature that further study is necessary.

Source: From kombucha, a mixture of fungi and bacteria from tea infusions

15. Acetobacter turbidans Cosbie, Tošić and Walker. (Jour, Inst Brewing, 48, 1942, 82)

This beer vinegar bacterium is characterized by the production of intense turbidity in beer and ale. The description given does not, at present, warrant recognition of the organism as a new species.

Source: From beer.

Bacterium dihydroxyacetonicum Virtanen and Bärlund. (Biochem, Zeit , 169, 1926, 170.)

There is no adequate description of this bacterium, and it is doubtful whether it can be properly evaluated since various species of Acetobacter also possess the ability to produce dihydroxyacetone from giveerol. Consideration of this as a nomen nudem was indicated by Virtanen to Vaughn in a personal communication in 1938.

Source: From beet juice.

17 Acetobacter peroxydans Visser 't Hooft, (Inaug. Diss., Delft, 1925, 98) The exact taxonomic position of this

bacterium will not be clear until further comparative studies have been made. Source From hydrogen peroxide solutions.

Genus V Protaminobacter den Dooren de Jong.

(Bijdrage tot de kennis van het mincralisatieproces Thesis, Rotterdam, 1926, 159.) From M L, protamine and Latin, bactrum, rod

Capable of dissimulating alkylamins Pigmentation Cells motile or non-motile frequent. Soil or water forms

The type species is Protaminobacter alboftavum den Dooren de Jong.

Key to the species of genus Protaminobacter.

I. Non-motile. Gelatin colonies light yellow to colorless.

1. Protaminobacter alboftavum

II, Motile Gelatin colonies red

Protaminobacter rubrum.

I. Protaminobacter alboflavum den Dooren de Jong (Thesis, Rotterdam, 1926, 159; also see Cent. f Bakt , II

Abt , 71, 1927, 218.) From Latin albus, white; flavus, yellow. Rods · Non-motile. Gram-negative

\* It is uncertain at present who first used this combination.

<sup>†</sup> Prepared by Prof D H Bergey, Philadelphia, Pennsylvania, June, 1929; further revision by Prof Robert S Breed, New York State Experiment Station, Geneva New York, April, 1913.

Gelatin colonies: Circular, dry, light vellow or colorless.

Gelatin stab: No liquefaction.

Arar colonies: Circular, opaque, pigment bright red, yellow, light gray or

coloriess. Amine agar colonies: Circular, white to dark vellow.

See table below for list of organic substances utilized

2. Protaminobacter rubrum den Dooren de Jong. (Thesis, Rotterdam, 1926, 159; also see Cent. f. Bakt., II Abt., 71, 1927, 218.) From Latin, ruber, red.

Rods: Motile with single polar flagellum (Weaver, Samuels and Sherago. Jour. Bact., \$5, 1938, 59). Gram-negative.

Gelatin colonies: Circular, red, dry. Gelatin stab: No liquefaction.

TABLE 1 .- Organic Substances Utilized as a Source of Carbon by Varieties of Protaminobacter alboflavum

ORGANIC ACIDS	α	β	7	8	AMINO COMPOUNDS		β	7	8	AMINES	α	B	7	٥
Acetic	+	+	+	+	a alanın	0	0	+	+	Etbyl	1	1	+	4
Valerianic	+.	+	0	+1	α - aminocapronic	١.		Ι.		Dietbyl .	+	+	0	10
		1	ì		acid	+	0	+	0	Propyl .	+	+	+	Ì +
a-crotonie	+	+	+	+	Leucin	+	+	0	0	Isopropyl .	0	+	0	0
Undecyclic	0	0	0	+1	Propionamid	+	0	+	0	Dipropyl	+	+	0	0
Lactic	+	0	0	+	Capronamid	+	0	+	0 [	Tripropyl	+	0	0	0
β-oxybutyric	+	+	+	+	Uric scid	+	0	0	0	Butyl	+	0	+	0
Succinic	+	+	+	+	Hippuric acid	+	0	0	0	Isobutyl .	+	+	+	+
Formic	+	+	+	+						Diisobutyl	+	+	0	0
Glutaric	0	+	0	+	ALCOHOL					Amyl	+	+	+	+
Adipie	0	0	0	+			1			Diamyl	0	+	0	Į o
Fumaric	+	+	+	+	Ethyl	+	+	+	+	Ethanol .	+	+	+	+
Malie	+	+1	+ i	+	Luyi	7	🗆	7	7,	Glucosamin	+	+	+	0
Tartaric	0	+	0	0						Benzyl	+	0	+	0
Citric	+	+	+	+	BUGAR			1						
β-phenylpropi-										'	- 1			
onte	+	0	0	0	Glucose	+	+ (	+ [	0 (		- 1			l
Quinic	+ 1	+	0	0	1				- 1					

Catalase is formed. Aerobic, facultative. Optimum temperature 30°C. Hobitat · Soil and water

Note: The author recognizes four varieties of this species which he differentiates on the basis of organic substances attacked (see Table) and pigment produced. Variety a shows light vellow growth on gelatin, bright red on agar and vellow on amine agar. Variety B is light yellow on gelatin, yellow on agar and dark yellow on amine agar. Variety γ is light yellow on gelatin, light gray on agar and yellow on amine agar. Variety δ is colorless on gelatin and agar and white on amine agar

Agar colonies: Circular, red, opaque. Amine agar colonies: Circular, dark red.

The following organic acids are attacked: Acetic, lactic, \$\beta\$-oxybutyric, glycerinic, succinic, malonic, formic, methyl formic, glutaric, maleinic, fumarie, malie, tartarie, citric and quinic.

The following amino compounds are attacked: Sarcosin, betain, hippuric acid, asparagine, propionamid, capronamid, lactamid, succinamid, allantoin and uric acid.

Glucose is fermented. Catalase is formed. Aerobic, facultative.

Optimum temperature 30°C. Habitat : Soil and water.

#### Genus VI. Mycoplana Gray and Thornton.\*

(Cent. f. Bakt., II Abt., 73, 1928, 82.) From Greek, mykes, fungus; plane, a wanderer or traveller.

Cells branching, especially in young cultures. Frequently banded when stained. Capable of using phenol and similar aromatic compounds as a sole source of energy. Grow well on standard culture media.

Type species Mycoplana dimorpha Gray and Thornton.

#### Key to the species of genus Mycoplana.

I. Gelatin not liquefied.

If Colotic Houseled

Gelatia liquefied.

1. Mycoplana dimorpha.

2 Mycoplana bullata.

 Mycoplans dimorphs Gray and Thornton. (Cent. f. Bakt., II Abt., 75, 1928, 82.) From Greek, ds., two; morphos, forms.

Short, curved and irregular rods, 0.5 to 0.7 by 1.25 to 4.5 microns, showing branching especially in young cultures Mottle, with long polar flagella. Gramnegative.

Gelatin colonies: Circular, buff, smooth, resinous, entire.

Gelatin stab: No liquefaction. Growth fillform.

Agar colonies: Circular, buff, convex, smooth, glistening, entire

Agar slant: Filiform, white, convex, glistening, entire

Broth: Turbid, with surface ring

Nitrites not produced from nitrates but cas evolved in fermentation tubes Starch hydrolyzed.

No acid from carbohydrate media Attacks phenol

Aerobie.

Optimum temperature below 30°C Source: One strain isolated from soil Habitat: Probably in soil Mycopiana outtata.

Mycoplana bullata Grny and Thornton (Cent. f. Bakt., II Abt., 73, 1928,
 From Latin, bullatus, furnished with a bass or knob.

Rods, curved and irregular, branching, 0.8 to 10 by 2.25 to 4.5 microns. (Motile with polar fagella. Gram-negative. Gelatin colonies Circular, buff, smooth, glistening, edge diffuse. Partially liquefied.

Gelatin stab Saccate liquefaction.

Agar colonies: Circular, white, consex, smooth, glistening, entire

Agar slant. Filiform, white, convex, smooth, glistening, entire.

Broth. Turbid
Nitrates not produced from nitrates.

Gas, presumably N, in fermentation tubes.

Starch not hydrolyzed

No acid from carbohydrate media. Attacks phenol.

Acrobic

Optimum temperature below 30°C.
Source Two strains isolated from soil.
Habitat: Probably in soil.

Prepared by Prof. D. H. Bergey, Philadelphia, Pennsylvania, June, 1929

<sup>†</sup> The original statements regarding the flagellation of these species are contradictory. The first reads "Polar, pentrichous, the second "Polar or peritrichous". Drawings given usually indicate pentrichous rather than polar flagellation. Further study is needed before these species can be properly placed in relation to other known species.—Editors

TRIBE II. SPIRILLEAU KLUYVER AND VAN NIEL. (Cent. f. Bakt., II Abt., 94, 1936, 346.)

More or less spirally curved cells.

#### Key to the genera of tribe Spirilleae.

- I. Generally motile by means of a single polar flagellum.
  - A. Short, bent rods occurring singly or united into spirals.
  - Genus I. Vibrio, p. 192.
  - B. Slightly curved rods of variable length. Strict anaerobes which reduce sulfates to hydrogen sulfide.
    - Genus II. Desulfovibrio, p. 207.
  - C. Cells oxidize cellulose forming oxycellulose. Growth on ordinary culture media is feeble.
    - 1. Long, slightly curved rods with rounded ends.
      - Genus III. Cellvibrio, p. 209.
    - 2. Short, curve-1 rods with pointed ends.
- Genus IV. Cellfalcicula, p. 211.
- II. Generally motile by means of a tuft of polar flagella. Cells of varying thickness, and length and pitch of spiral, forming either long curves or portions of a turn
  - A. Oxidize inorganic sulfur compounds. Cells contain free sulfur granules. Genus V. Thiospira, p. 212.
  - B. Not as above.

Genus VI. Spirillum, p. 212.

#### Genus I. Vibrio Müller.\*

(Muller, Vermum terrestrium et fluviatilum, 1, 1773, 39; Pacinia Trevisan, Attid. Accad Fisio-Medico-Statistica in Milano, Ser 4, 5, 1885, 83; Microspira Schroeter in Cohn, Kryptogamen-Flora von Schlesien, 3, 1, 1886, 168; Pseudospira De Toni and Trevisan, Sylloge Fungorum, 8, 1889, 1018, Photobacterium Beijerinck, Arch. néerl. d. sei exactes, 23, 1889, 401; Luquidovibrio Orla-lensen, Cent. f. Bakt. II Abt., 22, 1909, 333; Solidovibrio Orla-Jensen, ibid; Dicrospira Enderlein, Sitzber. Ges naturf. Freunde, Berlin, 1917, 313) From Latin, vibro, vibrate.

Cells short, curved, single or united into spirals. Motile by means of a single polar flagellum which is usually relatively short; rarely, two or three flagella in one tult. They grow well and rapidly on the surface of standard culture media. Aerobic to

anaerobic species. Mostly water forms, a few parasites.

The type species is Vibrio comma (Schroeter) Winslow et al.

### Key to the species of genus Vibrio.

- I. Gelatin liquefied.
  - A. Nitrites produced from nitrates.
    - Indole is formed.
      - a Milk not coagulated.
        - Vibrio comma.
          - 2. Vibrio berolinensis.
      - aa. Milk coagulated.
- 3. Vibrio metschnikovii.

Revised by Prof D H. Bergey, Philadelphia, Pennsylvania, April, 1937; partial revision by Capt. Wm. C. Haynes, Sn.C., Fort Bliss, Texas, July, 1943 and by Lt. Col. A. Parker Hitchens, University of Pennsylvania, Philadelphia, Penna., December, 1943.

- 2. Indole not formed.
  - a. Milk not coagulated.
    - Vibrio tyrogenus.
       Vibrio zenopus.
- B. Nitrites not produced from nitrates.
  - 1. Indole is formed
    - a. Milk congulated, peptonized
    - 6 Vibrio piscium.
    - Indole not formed.
      - a Milk acid, coagulated
        - 7 Vibrio proteus.
          - 8 Vabrao wolfia
          - 9. Vibrio sputigenus.
        - 10 Vibrio liquefaciens
        - sa. Milk not coagulated b Growth on potato thin, barely visible
          - 11. Vibrao sirietus.
          - bh No growth on potato
          - 12 Vibreo aquatilis
      - aza. Action on milk not reported
        - b Acid from glucose Attacks naphthalene.
          - 13 Vibrao neocistes

            the No acid from carbohydrates Attacks naphthalene
          - 14 Vibrzo cuncatus
            bbb No acid from carbohydrates Liquefies agar
- II. Gelatin not liquefied
  - A. Nitrites produced from mitrates
    - 1. Acid and gas from glucose
- 16 Vibrio leonardii

15 Vibreo grants

- 2. Acid but not gas from glucose Liquefies agar.

  17 Vibrio agarliquefaciens
- B. Nitrates not produced from natrates
  - Acid from glucose
    - 18 Vibrio cyclosiles
      2. No acid from carbohydrates
      - s 19 Vibrio percolans
- C Nitrite production not reported
  - Requires the addition of ammonium sulfate for growth Ammonium sulfate agar liquefied.
    - 20 Vibrio ander.

      2. Do not require ammonium sulfate for growth
      - a Indole not formed

        b. Microserophilic, becoming serobic.
        - b. Microseropmire, becoming across
        - bli Aerobic, facultative
          22 Vibria pierantonii,
- 1. Vibrio comma (Schroeter) Winslow et al. (Kommakacilius, Koch, Berliner klin, Wochenschr, 21, 1881.
  - 479; Spirillum cholerae asiaticae Zopf, Die Spaltpilze, 3 Auff., 1885, 69, Parinin choleraeassaticae Trexisan, Atti d. Accad

Fisio-Med.-Statistica in Milano, Scr. 4, 5, 1885, 84; Microspira comma Schroeter, in Cohn, Kryptogamen Flora v. Schlesien, 5, 1, 1886, 105; Vibrio cholerae Neisser, Arch. f. Hyg., 19, 1893, 199; Vibrio cholerae asiaticae Pfeiffer, in Flügge, Die Mikroorganismen, 2, 1890, 527; Winslow et al., Jour. Bact., 6, 1920, 204; Bacillus cholerae Holland, Jour. Bact., 5, 1920, 217; Bacillus comma Holland, did., 218; Spirillum cholerae-asiaticae Holland, ibid., 225; Vibrio cholerae-asiaticae Holland, ibid., 225; Vibrio cholerae-asiaticae Holland, ibid., 220.) From Latin, comma.

Slightly curved rods, 0.3 to 0.6 by 1 0 to 5.0 merons, occurring singly and in spiral chains. Cells may be long, thin and delicate or short and thick. May lose their curved form on artificial cultivation. Motile, possessing a single polar flagellum. Gram-negative.

Gelatin colonies: Small, yellowish-

Gelatin stab: Rapid napiform liquefaction

Agar colonies Circular, whitish brown, moist, glistening, translucent, slightly raised, entire.

Agar slant: Brownish-gray, moist, glistening.

McConkey's medium: Good growth, colonics colorless when young, soon pinkish, medium becomes darker red.

Broth: Slightly turbid, with fragile, wrinkled pellicle and flocculent precipitate.

Peptone water: Characteristic rapid growth, chiefly at surface, where after 6 to 9 hours, a delicate membrane is formed; little turbidity, deposit apparently derived from pellicle (Topley and Wilson, Princip. Bact and Immun., 2nd ed., 1936, 388) Readily isolated from the surface film of 0.1 per cent peptone water.

Litmus milk Alkaline at the top and slightly acid at bottom; generally not coagulated; peptonized; reduced Potato: Dirty-white to yellowish, moist, . glistening, spreading.

Blood scrum: Abundant growth, sometimes slow liquefaction.

Blood agar: The blood pigment is digested forming a greenish zone around colonies; a true soluble hemolysin is not formed (the El Tor vibrio also digests blood pigment but in addition produces a soluble hemolysin. Otherwise it is said to be indistinguishable from the typical cholera vibrio).

Indole is formed.
Nitrites produced from nitrates.

Cholera-red reaction, which depends on production of indole and reduction of nitrates is positive.

Hydrogen sulfide is formed.

Acid but not gas from glucose, fructose, galactose, maltose, sucrose and mannitol. Slowly from glycerol. Does not attack lactose, inulin or dulcitol.

Group I of Heiberg (Classification of Vibrio cholerae and Cholera-like Vibrios. Copenhagen, 1935) ferments mannose and sucrose but not arabinose.

Hydrolyzes starch actively in alkaline media.

High alkali but low acid tolerance; optimum pH 7.6 to 8.0; for isolation on Dieudonne's medium pH 9.0 to 9.6.

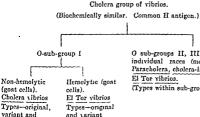
Aerobic, grows best in abundant ovygen; under strict anaerobiosis may fail to grow altogether.

Optimum temperature 37°C. Maximum 42°C. Minimum 14°C.

Source: From intestinal contents of cholera patients in Egypt and India

Habitat: Intestinal contents of cholera patients and carriers.

The relationships existing among the cholerigenic and non-pathogenic water vibrios, although studied intensively, have not yet been completely defined. As a working scheme, based on somatic (O) and flagellar (H) antigen studies, Gardner and Vankatraman (Jour. Hys. 55, 1935, 262-282) suggest the following



(?middle)

Linton (Bact. Rev., 4, 1940, 275) has outlined a classification of the vibrios based upon their protein and polysaccharide structures Using chemical methods, it was found that one polysaccharide and one protein was commonly obtained from each strain of vibro; when exceptions occurred, it was invariably noted that the strain was undergoing dissociation. Given a single protein and polysaccharide in each vibrio, it was possible to divide the strains into six groups, which were numbered in the order of their discovery as shown in the table

middle.

A chemical grouping of the cholerigenic and water ribrios

Group	Protein Type	Polyeaccharide Type
1	ı	I
11	1	11
111	11	11
IV	11	1
v	II	III
VI	1 I	111

The strains of Groups I and II possess the same protein and different polysaccharides. These are derived from cases of cholera and have the serological O sub-groups II, III, IV, V, VI and individual races (mostly hemolytic). Paracholera, cholera-like, and some

El Tor vibrios. (Types within sub-groups underlined )

and brochemical characteristics of O-Group I. Vibrio cholera. Group I strains are more common than those of Group II. which have, honever, been isolated from epidemics with a high mortality. The phospholipid fraction is common to both types when isolated in the early part of an epidemic, but is not found in strains of other groups The harmless water vibrios, which are so heteroreneous serologically (Taylor and Ahuia, Indian Jour. Med Res., 26, 1938, 8-32) form a single chemical group with a homogeneous structure. They fall into Group III, which differs in its protein structure from the authentic cholera vibrios, and resembles Group II in its polysaccharide The vibries of Group IV, which came from El Tor and from chronic vibrio carriers are believed on epidemiological grounds to be harmless. although serological methods have failed to distinguish them from cholerigenic vibrios Group V, which, like III and IV, contains protein II, consists, like Group IV. of strains from chronic vibrio carriers. Group VI strains are only rarely isolated in nature and representatives of this group are generally found among collections of old laboratory They appear to be the result of polysaccharide variation from Group I

after long-continued growth on artificial

2 Vibrio berolinensis Neisser. (Arch. I Hyg., 19, 1893, 200; Microspira berolinensis Migula, in Engler and Pranti, Die naturi. Pflanzenfam., 1, 1a, 1895, 33.) From M. L., the genitive of Berolina, the Latin name for Berlin.

Curved rods, somewhat smaller than Vibrio comma. Frequently occurring in pairs. Mottle, possessing a polar flagellum Pleomorphic. Gram-negative.

Gelatin colonies: Small, grayish, slightly granular, fragmented.

Gelatin stab: Slow, napiform liquefaction.

Agar slant: Grayish-yellow, moist,

glistening Broth: Turbid, with gray pellicle.

Litmus milk No coagulation, no acid.

Potato: Brownish streak.

Indole is formed

Nitrites produced from nitrates. Not pathogenic for mice, pigeons or

guinea pigs.

Aerobic, facultative.

Optimum temperature 37°C Minimum above 10°C. Maximum less than

60°C. Source · Isolated from filtered Spree river water.

3. Vibrio metschnikovil Gamaléia. (Gamaléia, Ann. Inst Pasteur, 2, 1883, 482; Pacinia metschnikofi Trevisan, I generi e le specie delle Batteriacee, 1880, 3; Sprillum metschnikovi Sternberg, Man of Bact., 1893, 511, Vibrio nordhafen Pfuhl, Ztschr f Hyg., 22, 1894, 234; Microspira metschnikofii Migula, in Engler and Prantl, Die naturi Pflanzenfam, 1, 1a, 1895, 33.) Named for Metschnikoffi. Russian bacteriologist.

Probable synonyms Vibrio schuyl. kiliensis Abbott, Jour. Exp Med. 1, 1896, 424 (Microspira schuylkiliensis Chester, Manual Determ. Bact., 1901, 334); Vibrio danubicus Heider, Cent. f. Bakt., 14, 1893, 341 (Microspira danubica Migula in Engler and Prantl, Die natürl. Pflanzenfam., 1, 1a, 1895, 33; Spirillum danubicum Holland, Jour. Baet, 5, 1920, 225).

Curved rods, somewhat shorter and thicker than Vibrio comma. Motile Gram-negative.

Gelatin colonies: Like those of Vibrio

Gelatin stab: Rapid, napiform liquefaction.

Agar slant: Yellowish, plumose, moist,

glistening. Broth: Turbid, with thin, white pel-

Litmus milk: Acid, coagulated (eighth day); not peptonized.

Potato: Delicate, brownish growth.

Indole is formed. Nitrites produced from nitrates.

Pathogenic for pigeons, fowls, and guinea pigs.

Aerobic, facultative.

Optimum temperature 37°C, Maximum less than 45°C.

Source Isolated from fowl dead of a cholerate disease.

Habitat: The intestinal contents of chickens, pigeons and other animals suffering from a cholera-like disease.

4 Vibrio tyrogenus (Flügge) Holland (Käsespirillen, Dencke, Deutschmed. Wochnschr., II, 1885, 33; Spirillem tyrogenum Flugge, Die Mikroorganismen, 2 Aufl., 1886, 386; Pacina denckei Trevisan, I generi ele specio delle Batteriacce, 1889, 23; Microspira tyrogena Migula, in Engler and Prantl, Die naturl. Pflazenfam., I, 1a, 1895, 33; Holland, Jour. Bact, δ, 1920, 225, Vibrio dender, Hauduroy et al., Dict. d. Bact. Path, 1937, 541.) From Greek tyros, cheese, genes, produced from.

Curved rods, rather smaller and more slender than Vibrio comma, often very long, closely wound spirals Motile, possessing a polar flagellum. Gramnegative Gelatin colonies: Small, gray, granular, entire.

Gelatin stab Rapid, saccate liquefaction
Agar slant: Yellowish-white, plumose,

glistening. Broth: Turbid.

Broth: Turbid. Litmus milk: Not coagulated

Potato: No growth. Indole not formed.

Slight production of nitrates from

Aerobic, facultative.

Optimum temperature 30°C Source. Isolated from cheese

5 Vibrio xenopus Schrire and Greenfield (Trans Royal Soc So Africa, 17, 1930, 309.) From Xenopus, a genus of African toads.

Spiral forms, occurring singly and in pairs. Non-motile. Gram-negative

Gelatin stab: Slow, crateriform liquefaction.

Agar colonies: Small, white, glistening, slimy, entire.

Agar slant. Grayish-white, slimy, entire.

Broth: Turbid with flocculent sedi-

Litmus milk: Unchanged.

Potato: Not reported.
Indole is not formed

Nitrites are produced slowly from nitrates.

Blood serum is peptonized

Starch is not hydrolyzed.

Acid from glucose, fructose, maltose,

glycerol and sorbitol.

Aerobic, facultative.

Optimum temperature 37°C. Source: Found in abscess of pectoral

muscle of African toad.

6. Vibrio piscium David. (Cent. f. Bakt., I Abt., Orig , 102, 1927, 46.) From Latin piscis, fish

Curved rods: 0.3 to 0 5 by 2 0 microns. Motile with a single polar flagellum. Gram-negative. Gelatin colonies: Circular, granular, paque Gelatin stab: Napiform liquefaction.

Agar colonies: Yellowish, circular, smooth, entire, indescent.

Agar slant · Light yellow, transparent streak.

Broth: Slight turbidity, with thin pellicle.

Litmus milk: Soft congulum. Peptonized, alkaline.

Potato: Brownish-red streak

Indole is formed

Nitrites not produced from nitrates.

Hydrogen sulfide formed. No action in sugar media.

Pathogenic for frogs.

Aerobic, facultative.

Optimum temperature 18° to 20°C. Habitat Causes epidemic infection in fish.

7. Vibrio proteus Buchner (Kommabacillus der cholcra nostras, Finkler and Prior, Deutsche med Wochenschr., 1884, 632; Buchner, Sitzungsber. d Gesel, f Morph u. Physiol., Munchen, Heft 1, 1885, 10; Pacinia finkleri Trevisan, Attı d. Accad, Fisio-Medico-Statistica in Milano, Ser. 4, 3, 1885, 84; Microspira finkleri Schroeter, in Cohn, Krytogamen-Flora von Schlesien, 3, 1, 1886, 168, Spirillum finkleri Crookshank, Man. of Bact , 3rd ed., 1890, 282; Microspira protea Chester, Manual of Determinative Bacteriology, 1901, 338, Vibrio finkleri Holland, Jour Bact., 5, 1920, 225.) From Greek, Proteus, a marine derty who had the power of assuming any shape he chose. Curved rods: 0.4 to 0 6 by 2.4 microns,

often pointed at both ends Motile, possessing a polar flagellum. Gramnegative

Gelatin colonies · Small, gray, circular, granular, entire

Gelatin stab: Rapid, saccate liquefaction.

Agar slant: Dirty grayish, plumoec. Broth: Turbid, with fetid odor.

Litmus milk: Slightly acid: coagulated: peptonized.

Potato: Gravish, slimy layer.

Indole not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Optimum temperature 30°C. Source: Isolated from feces of pa-

tients suffering from cholera nostras.

Habitat: Intestinal contents in cholers postrue and cholere infantum

8. Vibrio wolfil (Migula) Bergey et al. (Bacillus choleroides Wolf, Münch, med. Wochenschr , 40, 1893, 693; Microspira wolfii Migula, Syst. d. Bakt., 2, 1900. 1001; not Microspira choleroides Migula, loc. cit , 992; Bergey et al., Manual, 1st ed., 1923, 80 ) Named for Wolf, who first isolated this organism.

Curved rods and S-shaped forms.

Motile. Gram-negative Gelatin colonies: Small, gravish-white.

spreading Gelatin stab. Infundibuliform lique-

faction. Agar slant: Grav, moist layer, Broth: Turbid, with gray pellicle Litmus milk: Acid: coagulated.

Potato Yellowish-white laver.

Blood serum: Rapid liquefaction. Indole not formed. Nitrites not produced from nitrates.

Aerobic, facultative.

Optimum temperature 37°C.

Source: Isolated from cervical secretions in chronic endometritis.

9. Vibrio sputigenus (Migula) Bergey et al. (Vibrio aus Sputum, Brix, Hyg. Rundschau, 4, 1894, 913; Microspira sputigena Migula, Syst. d. Bakt., 2, 1900. 981; Bergey et al , Manual, 1st ed., 1923. 80.) From Latin, spuo (sputus), sputum; -genes, produced from.

Slightly curved rods, about the same size and form as Vibrio comma, occurring singly, occasionally three or four in a chain. Motile. Possessing a polar flagellum. Gram-negative.

Gelatin colonies: Small, circular. slightly granular, yellowish, becoming hownish.

Gelatin: Crateriform liquefaction. Agar slant: Grayish-white, moist.

Broth: Turbid, no pellicle formed. Litmus milk: Acid: coagulated. Potato: Thin, gray layer, spreading,

Indole not formed. Nitrites not produced from nitrates.

Aerobic, facultative. Optimum temperature 37°C.

Source: Isolated from soutum.

10. Vibrio liquefaciens (Migula) Bergev et al. (Bonhoff, Arch. f. Hvg., 19, 1893, 218; Microspira liquefaciens Migula, Syst. d. Bakt., 2, 1900, 990; Bergey et al., Manual, 1st ed., 1923, 81.) From Latin, liquefacio, to make liquid. Comma and S-shaped rods. Motile.

Gram-negative. Gelatin colonies: Circular, with ir-

regular margin, surrounded by a rosecolored zone.

Gelatin stab: Slow, napiform liquefaction.

Agar slant: Smooth, gravish, plumose. Broth: Turbid, with heavy grayish pellicle.

Litmus milk: Acid; coagulated. Potato: Moist, brownish layer.

Indole is not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Optimum temperature 37°C. Habitat: Water.

(Ztschr. 11. Vibrio strictus Kutscher. f. Hyg., 19, 1895, 469.) From Latin stringo (strictus), constricted.

Markedly curved rods, of about twice the size of Vibrio comma. Motile. Gram-negative.

Gelatin colonies: Small, circular, yellowish, with serrate margin.

Gelatin stab: Slow, napiform to saccate liquefaction.

Agar slant: Growth plumose, moist Broth: Turbid, with gray pellicle.

Litmus milk: Not coagulated.
Potato: Thin, barely visible layer.
Blood serum is slowly liquefied.
Indole is not formed.

Nitrites not produced from nitrates. Pathogenic for guinea pigs.

Aerobic, facultative. Optimum temperature 37°C.

Optimum temperature Habitat: Water.

12 Vibrio aquatilis Günther. (Deut-

sche med. Wochenschr., 1892, 1124; Microspira aquatilis Migula, System der Bakterien, 2, 1900, 993.) From Latin, aquaticus, living in water

Curved rods, like Vibrio comma Motile, possessing a polar flagellum Gram-negative.

Gelatin colonies: Circular, brownish,

finely granular, entire

Gelatin stab: Crateriform liquefaction Agar slant: Moist, grayish, glistening

Broth: Slightly turbid. Litmus milk: Not coagulated

Potato · No growth

Indole not formed Nitrites not produced from nitrates

Aerobic, facultative Optimum temperature 30°C

Habitat: Water.

13. Vibrio neocistes Gray and Thornton. (Gray and Thornton, Cent f Bakt, II Abt., 73, 1928, 92) From Greek néos, new and Listé box or ark Here used as the equivalent of Newark.

the name of a city in England
Curved rods. 0 5 to 10 by 10 to 40
microns. Motile with one to three
polar flagella. Gram stain not recorded.

Gelatin colonies: Liquefied Gelatin stab: Liquefied. Medium red-

dened.
Agar colonies: Circular or amoeboid,
buff to brownish, convex, smooth, glis-

tening, entire.
Agar slant . Filiform, fluorescent, raised,

smooth, glistening, undulate. Broth: Turbid.

Nitrites not produced from nitrates Starch not hydrolyzed. Acid from glucose. Attacks naphthalene. Aerobic, facultative. Optimum temperature. Habitat: Soil.

14 Vibrio cuneatus Gray and Thornton. (Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 92.) From Latin, cuneo (cuneatus) wedge.

Curved rods: 10 by 1.0 to 30 microns, the cells tapering at one extremity. Motile with one to five polar flagella. Gram-negative.

Gelatin colonies: Liquefied.

Gelatin stab: Liquefied

Agar colonies: Circular to amoeboid, white to bull, flat to convex, smooth, translucent, border entire.

Agar slant: Filiform, whitish, smooth, glistening.

Indole not recorded.

Nitrites not produced from nitrates Starch not hydrolyzed

No acid from carbohydrate media.

Attacks naphthalene

Acrobic, facultative

Optimum temperature 30° to 35°C. Source: One strain isolated from soil from Rothamsted, England.

Habitat Soil

15 Vibrio granii (Lundestad) Stanier. (Bacterium granii Lundestad) Cent. f. Bakt., II Abt., 75, 1928, 330; Achromobacter granii Bergey et al., Manual, 3rd ed., 1930, 222, Stanier, Jour. Bact., 42, 1941, 533) Named for Prof II. II. Gran, who first detected gar-luqufying bacteria.
Rods 0 6 to 0 8 by 1 4 to 2 4 microns,

with rounded ends, occurring singly, in pairs, and at times in short chains. Motile. Polar flagellate (Stanier, loc. cit.). Gram-negative.

Fish-gelatin colonies: Punctiform, black, glistening.

Fish-gelatin stab: Slow, erateriform liquefaction.

Sea-weed agar colonies: Circular, flat.

opaque, glistening, white, slimy, entire. Agar is dissolved.

Fish-agar slant. I'lat, white, elevated, glistening, undulate. Liquefied.

Broth: Turbid with grayish-white, slimy sediment.

Indole not formed.

Nitrites not produced from nitrates. Starch usually hydrolyzed.

No action on sugars.

Aerobic, facultative.

Optimum temperature 20° to 25°C,

Source: Sea water of Norwegian Coast. Habitat: Presumably sea water and on sea weeds

16. Vibrio leonardii Métalnikov and Chorine. (Ann. d. l'Inst Pasteur, 42, 1928, 1647) Named for Leonard.

Curved rods with rounded ends, 0.5 to 1.0 by 2.0 to 3.0 microns. Motile with 1 to 3 polar flagella. Gram-negative. Gelatin stab. No Inquefaction.

Agar colonies Small, transparent, cir-

cular, having a characteristic odor.

Broth. Turbid, with thin pellicle.

Litmus raik No congulation, acid.

with reduction of litmus.

Potato Slight, colorless growth

Indole not formed Nitrites produced from nitrates

Blood serum not liquefied Hydrogen sulfide formed.

Acid and gas from glucose, fructose, galactose, lactose, sucrose and mannitol. No acid or gas from maltose or glycerol. Acrobic, facultative

Optimum temperature 30°C

Habitat: Highly pathogenic for insects as Galleria mellonella L. (bee moth), and Pyrausta nubialis Hübn. (European corn borer).

17. Vibrio agarliquefaciens (Gray and Chalmers) Bergey et al. (Microspira agar-liquefaciens Gray and Chalmers, Ann. Appl Biol., 11, 1924, 325; Manual, 4th ed, 1934, 119.)) From Latin, hquefacio, liquelying; Mulay, agar, a jelly from seaweeds.

Short curved rods, usually c-shaped,

with occasional s-shaped and coccoid forms. Cells 20 microns long by 0.5 to 0.7 micron broad; 3.0 to 50 microns long in division stages. Coccoid forms stained, 0.5 to 0.7 micron long. Mottle with a single polar flagellum. Gramstain not reported.

Gelatin stab: Very slight surface growth after one month; the streak then shows a beaded line. No liquefaction.

Agar colonies: Surface colonies appear as a whitish growth in a depression, surrounded by a white ring. The colony is later surrounded by a ring of liquid agar. Deep colonies show a clear area and may be irregular, oval or angular.

Agar slant: A deep groove is cut along the inoculation streak, whitish growth along sides. The gel is later much weakened.

Broth: Slightly turbid. No pellicle.
Acid from glucose, lactose and mal-

tose. No acid from sucrose or glycerine.
Utilizes ammonia salts as a source of nitrogen.

Decomposes cellulose and agar. The presence of one per cent glucose prevents the liquefaction of agar.

Nitrites produced from nitrates.

Starch is hydrolyzed.

Aerobic.

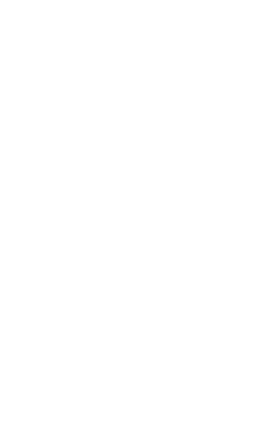
Temperature relations: Optimum 25° C., will grow at 16° but not at 34°C. Habitat: Soil.

 Vibrio cyclosites Gray and Thornton. (Gray and Thornton, Cent. für Bakt., II Abt., 75, 1925, 92.) From Greek kyklos, circle or ring; zittö, to cat; M.L. cyclosites, feeding on rings, i.e. ring compounds.

Curved rods: 0.5 to 1.0 by 1.5 to 40 microns. Motile with a single polar fingellum. Gram-negative.

Gelatin colonies: Circular, buff to brown, flat, smooth, glistening, entire.

Gelatin stab: No liquefaction.
Agar colonies: Circular to irregular,
pale buff (later greenish), smooth, entire.
Agar stab: Filiform, greenish buff,
raised, smooth, undulate.



Potato · No growth.

Indole not formed.

Nitrite production not reported.

Blood serum slant: Feeble growth. No liquefaction.

No gas from carbohydrates. No change or slightly acid from glucose, lactose and sucrose.

Optimum temperature 37°C. Withstands 55°C for 5 minutes.

Aerobic or microaerophilic

Pathogenesis Causes abortion in cattle. Source Twenty-two strains isolated from the placentas or fetuses of cows having abortion.

Habitat · Causes abortion in cattle

 Vibrio pierantonii (Zirpolo) Meissner. (Bacillus pierantoni: Zirpolo, Boll. Soc. nat. Napoli, 30, 1918, 206; Meissner, Cent. f Bakt, II Abt., 67, 1926, 200.)
 Named for Pierantoni, an Italian bacteriologist

Rods 05 by 15 microns, with rounded ends. Motile with one to three polar flagella Gram-negative

Gelatin colonies Circular, and irregu-

Gelatin stab · No liquefaction

Agar colonies: Circular, light green, smooth, entire

Glycerin agar slant. Slightly luminous streak.

Broth · Turbid, with pellicle

Indole not formed

Acid from glucose and maltose. Some strains also attack lactose, sucrose and mannitol.

Best growth in alkaline media Aerobic, facultative

Optimum temperature 37°C.

Source: Isolated from the photogenic organ of the cephalopod Sepiola intermedia Naef

Appendix:\* The following species have also been listed in the literature. Many are inadequately described Microspíra bonhoffii Migula. (Bonhoff, Arch. f. Hyg., 19, 1893, 252; Migula, Syst. d. Bakt., 2, 1900, 1008.) From water.

Microspira canalis Migula. (Spirillum saprophiles 7 and Vibrio saprophiles 7 Weibel, Cent. f. Bakt., 2, 1887, 469, Migula, Syst. d. Bakt., 2, 1900, 100t; Microspira cloaca Chester, Man. Detem. Bact., 1901, 341.) Possibly identical with Microspira saprophiles Migula, Microspira weibelii Migula, Vibrio sural Ford, Vibrio smithi Ford. From sewage.

Microspira coprophila Migula. (Group 3, No. 6, Kutscher, Ztschr. f. Hyg., 19, 1895, 475; Migula, Syst. der Bakt., 2, 1900, 986) From feeal matter.

Microspira massei (v. Hoff) Migula (Spirillum massei v. Hoff, Cent. f. Bakt., I Abt., 21, 1897, 797; Migula, Syst. d. Bakt., 2, 1900, 978.) Possibly a variely of Vibrio comma Winslow et al. From Rotterdam tap water.

Microspira milleri Migula. (Miller, Deutsche med. Wehnschr., 11, 1885, 188; Migula, Syst. d. Bakt., 2, 1900, 981; Spirillum milleri Holland, Jour. Bact., 5, 1920, 225; Vibrio milleri Holland, bid.) Probably identical with Vibrio proteus according to Migula. From dental caries

Microspira murmanensis Issatchenko. (Recherches sur les microbes de l'océan glacial arctique (in Russian), Petrograd, 1914, 240) From sea water.

Microspira saprophiles Migula. (Heuvibrio 8, Weibel, Cent. f. Bakt., 2, 1887, 409, Vibrio saprophiles P Weibel, Cent. f. Bakt., 4, 1888, 225; Migula, Syst. d. Bakt., 2, 1900, 1006; Microspira weibeli Chester, Man. Determ. Bact., 1901, 220.) Probably identical with Microspira clora Chester and Vibrio surati Ford. From sewage.

Microspira tyrosinalica Beijerinck.
(Kon. Akad Wetenschappen, Amsterdam, 13, 1911, 1068.) From sewage
Microspira tyribelii Migula. (Vibrio

Microspira weibelii Migula. (Vibrit

<sup>\*</sup> Prepared by Mr. Wm. C. Haynes, New York State Experiment Station, Geneva, New York, Jan \(\), 1939; Revised by Capt. Wm. C. Haynes, Sn. C., Fort Bliss, Texas, July, 1943.

saprophiles a Weibel, Cent. f. Bakt , 2, 1887, 465; ibid., 4, 1888, 225; Migula, Syst. d. Bakt , 2, 1900, 1005, Microspira saprophile Chester, Manual Determ Bact., 1901, 341; Vibrio saprophiles Ford. Textb. of Bakt., 1927, 356 ) Possibly identical with Microspira cloaca Chester. Vibrio surati Ford, Vibrio smithii Ford From sewage

Spirillum lipoferum Beijerinek (Cent. f. Bakt , II Abt , 63, 1925, 353; Chromatium lipoferum Bergey et al, Manual, 3rd ed , 1930, 531 ) From garden earth and sewage Giesberger (Beiträge zur Kenntnis der Gattung Spirillum Ehbg., Inaug Diss., Delft, 1936, 64) regards this organism as a Vibrio. Has a single polar flagellum

Spirillum nasıcola Trevisan (Nasenschleimvibrio, Weibel, Cent f Bakt, 2, 1887, 465; Trevisan, I genera e le specie delle Batteriacce, 1889, 24, Vibrio nasalis Eisenberg, Bakt. Diag , 3 Aufl , 1891, 213; Spirillum nasale Sternberg, Man of Bact., 1893, 697; Spirosoma nasale Migula, in Engler and Prantl, Die naturl. Pflanzenfam , 1, 1 a, 1895, 31.) From human nasal mucus.

Spirillum parvum Esmarch. (Cent. f Bakt., I Abt., Orig., 52, 1902, 565, also see Zettnow, 1bid., 78, 1916, 1, Vibrio pareus Lehmann and Neumann, Bakt Diag , 4 Aufl., 2, 1907, 491 ) From de-

caying organic matter.

Vibrio albensis Lehmann and Neumann (Elbe vibrio, Dunbar, Deutsch med. Wochnschr., 19, 1893, 799, Lehmann and Neumann, Bakt. Diag , 1 Aufl , 2, 1896, 340; Microspira dunbari Migula, Syst. d. Bakt., 2, 1900, 1013; Photospirillum dunbari Miquel and Cambier, Traité de Bact , Paris, 1902, 881; Photobactersum dunbari Ford, Textb. of Bakt., 1927, 621) From water of the river Elbe. Phosphorescent

Vibrio amylocella Gray. (Canad Jour. Res , 17, 1939, 154 ) Decomposes cellulose. Produces glucose from starch. From soil.

Vibrio anguillarum Bergman. (Ber. a. d. k. Bayr. Biolog. Versuchstat., München, 2, 1909.) From an infectious disease of cels.

Vibrio aureus Weibel. (Weibel, Cent f. Bakt., 4, 1888, 225, 257, 281; Spirillum aureum Trevisan, I generi e le specie delle Batteriacce, 1889, 24, Spirillum aureum Sternberg, Man of Bact., 1893, 700, Spirosoma aureum Migula, Syst. d. Bakt., 2, 1900, 958) Possibly identical with Vibrio flavus Weibel and Vibrio flavescens Weibel. From sewage.

Vibrio beijerinekii Stanier. Bact , 42, 1941, 527-554.) Marine agar-

digesting vibrio.

Vibrio buccalis Prévot (Vibrion B. Repaci, Compt. rend. Soc. Biol., Paris, 1909, 630; Prévot, Man de Classif. des Bact. Anaér., Paris, 1940, 82 ) Anaerobe From the buccal cavity.

Vibrio bulbosa Kalninš Universitātes Raksti, Serija I, No. 11, 1930, 237.) Decomposes cellulose From

50:1.

Vibrio cardii Klein (Cent f. Bakt., I Abt , Orig , 38, 1905, 173 ) Possibly identical with Vibrio cuneatus Gray and Thornton and Vibrio marinus Ford. From the mussel (Cardium edule)

Vibrio castra Kalninš (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 241.) Decomposes cellulose From soil.

Vibrio choleroides α and β Buiwid. (Cent f Bakt , 15, 1893, 120; Microspira choleroides Migula, Syst. d. Bakt , 2, 1900, 992) Probably a less vigorous strain of Vibrio comma Winslow et al. according to Chester, Man Determ Bact , 1901, 337. From water

Vibrio chrysanthemoides Lehmann and (Spirillum-like organism, Neumann. Jones, Cent f. Bakt., II Abt , 14, 1904, 459, Lehmann and Neumann, Bakt. Diag., 4 Aufl , 2, 1907, 493.) From five samples of tap water and sewage.

Vibrio crassus (Veillon and Repaci) (Spirillum crassum Veillon and Repaci, Ann Inst. Past., 26, 1912, 306; Prévot, Man. de Classif des Bact. Anaer., Paris, 1940, 85.) Anaerobe From the buccal cavity.

Vibrio crassus var. D, Prévot.

D, Repaci, Ann. Inst. Past., 26, 1912, 550; Prévot, Man. de Classif. des Bact. Anaér, Paris, 1910, 86.) Anaerobe. From the buccal cavity.

Vibrio crasters Hauduroy et al. (Craster, in Violle, Le Choléra, Masson édit, 1919, Hauduroy et al., Diet. d. Baet. Path., 1937, 541.) Isolated from healthy persons. Resembles Vibrio comma.

Vibrio cucumis Kalniņš. (Latvijas Ūniversitātes Raksti, Scrija I, No 11, 1930,243.) Decomposes cellulose. From soil

Vibrio devorans Beijerinck. (Cent. f. Bakt, II Abt., 11, 1903, 598) From water.

Vibro drennan: Chalmers and Water-field. (Drennan, Jour. Inf. Dis., 14, 1914, 251; Chalmers and Waterfield, Jour. Trop. Med., 19, 1916, 165.) Colonies white, turning dark brown. From feces.

Vibrio flarescens Weibel. (Cent. f. Bakt., 4, 1888, 225, 257, 281; Spirillum flavescens Trevisan, I generi e le specie delle Batteriacee, 1889, 24, Spirillum flavescens Sternberg, Man. of Bact., 1893, 700; Spirosoma flarescens Migula, Syst. d. Bakt., 2, 1900, 959) Possibly identical with Vibrio aureus Weibel and Vibrio flavus Weibel From sewage.

Vibro fauus Weibel. (Cent. f. Bakt, 4, 1888, 225, 257, 281, Sprillum flavum Trevisan, I genere le specie delle Batteriacce, 1889, 24; Sprillum flavum Sternberg, Man of Bact, 1893, 700; Sprrosoma flavum Migula, Syst. d. Bakt., 2, 1900, 959) Possibly identical with Vibrio aureus Weibel and Vibrio flavescens Weibel. From sewage

Vibrio fuscus Stamer (Jour. Bact., 42, 1941, 540.) Marine agar-digesting vibrio

Vibrio gauducheau Hauduroy et al. (Gauducheau, in Violle, Le Cholfera, Masson édit., 1919; Hauduroy et al., Dict. d. Bact., 1937, 543.) From the blood of a fever patient. Resembles Vibrio comma.

Vibrio ghinda Pfeiffer. (Pasquale,

Gior. med. d. r. esercito, 1891; Pfeiffer, in Flugge, Die Mikroorganismen, 2, 1896, 590; Microspira ghinda Migula, Syst. d Bakt., 2, 1900, 996.) From water,

Vibrio grossus (Migula) Ford. (Vibrio No. 1, Kutscher, Ztschr. f. Hyg., 20, 1895, 46; Microspira grossa Migula, Syst. d. Bakt., 2, 1990, 1012; Ford, Textb. of Bact., 1927, 343.) From liquid manure.

Vibrio halobicus desulfuricans Horowitz-Wlassowa and Sonntag. (Arb a. d. Staatl. wissensch. Nahrungsmittel-Institut 1931 (Russian); see Ztschr. f. Unters. d. Lebensm., 62, 1931, 597.) A halophilic vibrio found in salted sardines. anchovies and other marine fish.

Vibrio helcogenes Fischer. (Cent. f. Bakt., 14, 1894, 73; Microspira helcogenes Migula, Syst. d. Bakt., 2, 1909, 978) From descriptions, indistinguishable from Vibrio proteus according to Chester, Man. Determ. Bact., 1901, 339. From feeces.

Vibrio hyos Ford. (Vibrio No 3, Kutscher, Ztschr. f. Hyg., 20, 1895, 46; Spirillum mobile Migula, Syst. d. Bakt., 2, 1900, 1020; Ford, Textb. of Bact., 1927, 342.) Isolated from liquid manure.

Vibrio iners Besson, Ranque and Senez (Compt. rend. Soc. Biol. Paris, 79, 1918, 1007) From the feces of persons having dysentery.

Vibrio intermedius (Migula) Ford. (Group V, No. 9 of cholera-like vibrios, Kutscher, Ztschr. f. Hyg., 20, 1895, 481; Microspira intermedia Migula, Syst. d. Bakt. 2, 1900, 967; Ford, Textb. of Bact., 1927, 342.) Possibly identical with Vibrio beroluensis Neisser. From water.

Vibrio ivanoff Pfeiffer. (Ivanofi, Ztschr f. Hyg, 15, 1893, 134; Pfeiffer, in Flugge, Die Mikroörganismen, §, 1896, 552.) Probably a variety of Vibrio comma Winslow et al. according to Chester, Man. Determ. Bact., 1901, 37. From feces of a cholera patient.

Vibrio jejuni Jones, Orcutt and Little. (Jour. Exp. Med., 65, 1931, 853.) From small intestine of calves suffering from diarrhea.

Vibrio kegallensis Hauduroy et al.

(Diet. d. Baet. Path., 1937, 544) From water.

Vibrio klimenko Haudurov et al (Klimenko, in Violle, Le Choléra, Masson édit., 1919; Haudurov et al., Dict d Buct. Path., 1937, 544 ) Resembles Vibrio comma. From the intestine

Vibrio leidennis Horst (Inaug Diss Leiden, 1921; abst. in Cent f Bakt I Abt , Ref , 73, 1922, 282 ) From a hver

abscess.

\*Vibrio lingualis Eisenberg (Zungenbelag-Vibrio, Weibel, Cent f Bakt 4 1888, 227, Eisenberg, Bakt Drag , 3 Aufl , 1831, 212; Spirillum linguae Sternberg Man of Bact , 1893, 697, Spirosoma linguale Migula, in Engler and Prantl Die natürl, Pflanzenfam , 1, 1 a, 1895, 31 ) From deposit on the tongue

Vibrio lissabonensis Pestana Bettencourt. (Cent. f. Bakt , 16, 1891, 101 ) According to Chantemesse identical, or nearly so, with Vibrio proteus descriptions, industinguishable from Vibrio proteus according to Chester, Man Determ Bact., 1901, 339 From feces of a cholera patient.

Vibrio malamoria Kalnina (latvijas Umversitätes Raksti, Serija I. No. 11.

930, 250.) Decomposes cellulose From soil.

Vibria Ford (Russell) marinus (Spirillum marinum Russell, Zischr f Hyg. 11, 1891, 165, Microspira marina Migula, Syst. d. Bakt . 2, 1900, 1002, Ford, Texth of Bact , 1927, 317 ) From Met Water. Closely resembles cunculus Gray and Thornton and Vibrio cardei Klein

Vibrio massanah Philler (Pasquile, Gior, med. d. r esercito, 1891, Pasquile. Baummerten's Jahresberichte, 7, 1891, 326. Pfeifer, in Flügge, Die Miknorganismen. 2, 1896, 589, Microspira massasah Miguls, Syrt d Ralt., 2, 1900, 963, Spirillam marraunk Chester, Manual Determ Bart, 1901, 313, Spirillum marriagh H. Hand, Lour Bart, 5, 1920, 225, Vila: married Holland, that : From feers of a thelers patient

Vibrio mulieris Prévot (Man Classif des Bact, Anaér , Paris, 1910, 81 Anaerobe From the female general tract

Vibrio napi Kalning (Latvijas Uni versitätes Raksti, Serija I. No. 11, 1930. 252 ) Decomposes cellulose I'mm soil

Vibrio n'dianka Haudurov et al (Thironx, in Violle, Le Choléra, Masson édit . 1919, Hauduroy et al . Dict d Bact Path , 1937, 516 ) Isolated from a patient having a cholera like disease

Vibrio pericoma Kalnin's (Latvins Universitätes Raksti, Seriia I. No. 11. 1930, 256 ) Decomposes cellulose From Soul

Vibrio polymorphus Prévut (Spiro chete B, Repaci, Ann Inst Past, 26. 1912, 511. Vibrio pseudospirochaeta B. Weinberg, Nativelle and Prévot, Les Microbes Analrobies, 1936, 852, Privot, Man de Clarsif des Biet Anaér, Paris 1940, 83 ) Anaerobe From the buccal CALIES

Vibria polymorphus var peritriche Prévot (Spirochete C. Repart, Ann Inst Past , 26, 1912, 548, Vibrio preudo spirochacia C, Weinberg, Nativelle and Prévot, Les Microbes Anatrobies, 1936. 851. Prévot, Man de Classif des Bart Anier, Paris, 1910, \$1 ) Anaembe From the buccal cavity

Ushria portuenzis (Migula) Ford (Der portuenser Vibrio Jorge, Cent f Bakt , I Ahr. 19, 1896, 277, Vicrospira pertuen 219 Migula Syst d Bikt £ 1930, 1047, Ford Textb of Bart , 1927, 351 : From

nater Pibrio prima Kalnini - (Latvijis Cin versitătes Raksti Scrip I No. 11, 1920, 215 ) The comperer cellulose From scal

1 dru presed reperceracia (Spirishele A, Repue), Ann. Inst. Past., pr 1912, 57), Vibrio provi reprovi att 1 A. Weinberg, Naturelle and Privot, Les Microbes Americal on 1936, 49, Prime. Man de Chrest des Bert Aralt , Paris, 1910, 53.) Amende I nor the burest estiff

Librar patrides Privat. (Vibrata C. Report, Court well by But Pane.

<sup>\*</sup> her Noordia Ir gales Claimers and Clineopteron

1909, 630; Prévot, Man, de Classif, des Bact, Anaér., Paris, 1940, 83.) Anaerobe. From the buccal cavity.

Vibrio puogenes (Doerr) Lehmann and Neumann. (Eiterspirillum, Mezinescu, Cent. f. Bakt , I Abt., Orig., 55, 1904, 201; Spirillum pyogenes Doerr, Cent. f. Bakt., I Abt., Orig., 38, 1905, 15; Lehmann and Neumann, Bakt, Diag. 4 Aufl., 2, 1907, 493 ) From pus in a case of pyelitis calculosa, Non-motile.

Vibrio ranicula Kalninš, (Latvijas Universitātes Raksti, Serija I, No. 11, 1930, 248.) Decomposes cellulose. From

soil.

Vibrio rigensis Kalninš. (Latvijas Universitates Raksti, Serija I, No. 11, 1930, 254 ) Decomposes cellulose. From soil.

Vibrio rubicundus Gottron et al. (Gottron, Weaver and Sherago, Jour. Bact., 43, 1942, 61.) From a trickling filter

Vibrio septicus Kolle. (Kolle and Schumann in Kolle and Wassermann, Handb. d. path. Mikroorg., 2 Aufl., 4, 1912, 101 ) Identical with Vibrio comma culturally and morphologically. From a cholera-like disease,

Vibrio smithii (Migula) Ford (Smith, Cent f. Bakt , 10, 1891, 177; Microspira smithu Migula, Syst. d Bakt., 2, 1900, 1006; Ford, Textb of Bact , 1927, 340 ) Possibly identical with Microspira saprophiles Migula, Microspira weibelii Migula, Microspira cloaca Chester and Vibrio surati Ford From abscesses of large intestine of swine.

Vibrio spermatozoides Loffler. (Cent. f. Bakt., 7, 1890, 638.) From kohlrabi infusions.

Vibrio sputigenus (Miller) Prévot. (Spirillum sputigenum Miller, Die Mikroorg. d. Mundhöhle, 2nd ed , 1892; Prévot, Man, de Classif, des Bact, Anaér., Paris, 1940, 85; not Vibrio sputigenus Bergey et al., Manual, 1st ed., 1923, 80.) Anaerobe. From the buccal cavity.

Vibrio sputigenus var. minutissimus Prévot. (Muhlens, Cent. f. Bakt., I

Abt., 48, 1909, 523; Prévot, Man. de Classif. des Bact. Anaér., Paris, 1910, 85.) Anaerobe. From the buccal cavity.

Vibrio sputorum Prévot. (Man. de Classif. des Bact. Anaér., Paris, 1940, 85.) Anaerobe, Isolated from a case of bronchitis.

Vibrio stationis Kalnins. (Latvijas Universitätes Raksti, Serija I. No. 11. 1930, 239.) Decomposes cellulose. From soil.

Vibrio stomatitis Prévot. (Vibrion A. Repaci, Compt. rend. Soc. Biol. Paris, 1909, 630; Prévot, Man. de Classif. des Bact. Anaér., Paris, 1940, 82.) Anaerobe. From the buccal cavity.

Vibrio subtilissimus (Migula) Ford (Spirillum No. 1, Kutscher, Ztschr. f. Hyg., 20, 1895, 46; Spirillum tenerrimum Lehmann and Neuman, Bakt. Diag., 2, 1896,346; Spirillum subtilissimum Migula, Syst. d. Bakt., 2, 1900, 1020; Ford, Textb. of Bact., 1927, 341.) Regarded by Kutscher as being probably identical with the organism found by Smith (Cent. f. Bakt., 16, 1894, 324) in swine dung Resembles Vibrio strictus.

Vibrio suis Ford. (Vibrio No. 2, Kutscher, Ztschr. f. Hyg., 20, 1895, 46; Spirillum coprophilum Migula, Syst. d. Bakt , 2, 1900, 1019; not Microspira coprophila Migula, loc. cit., 986; Ford, Textb. of Bact., 1927, 341.) From liquid manure.

Vibrio surati (Lamb and Paton) Ford. (Spirillum surati Lamb and Paton, Arch. Int. Med., 12, 1913, 259; Treponema surati Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 514; Ford, Textb of Bact., 1927, 337.) Isolated from a case of vegetative endocarditis. Closely resembles Vibrio smithii Ford, Microspira weibelii Migula, Microspira saprophiles Migula and Microspira cloaca Chester.

Vibrio synthetica Kalninš. (Latvijas Universitates Raksti, Serija I, No. 11, 1930, 245.) Decomposes cellulose From soil.

Vibrio tenuis Veillon and Repaci.

(Ann. Inst. Past., 26, 1912, 300) As acrobe. From the buccal cavity.

Vibrio terrigenus Gunther. (Cent. f. Bakt. 16, 1894, 746; Spirillum terrigenum Migula, Syst. d. Bakt., 2, 1900, 1017; Microspira terrigena Chester, Man. Determ. Bact., 1901, 341.) Closely Determ. Bact., 1901, 341.) Closely Smith. From soil.

Vibrio tonsillaris Stephens and Smith. (Cent. f Bakt., 19, 1896, 929; Microspira tonsillaris Migula, Syst. d Bakt, 2,

1900, 1009.) Closely related to Vibrio terrigenus Gunther. From buccal cavity.

Vibrio toulonensis Hauduroy et al. (Vibrio Defressine and Caseneuve, in Violle, Le Cholèra, Masson édit., 1918; Hauduroy et al., Dict. d Bact. Path., 1937, \$47.) From mussel beds in the bay of Toulon.

Vibrio zylitico Kalnini (Latvijas Universitätes Raksti, Serija I, No. 11, 1930, 232.) Decomposes cellulose. From soil

#### Genus II. Desulfovibrio Kluyver and van Niel.\*

(Cent f. Bakt., II Abt., 94, 1936, 389, Sparoretrio Starkey, Arch. f. Mikrobiol., 9, 1938, 300) From M. L. desulfo, an abbreviation of the poorly constructed word desulfolication, used to indicate reduction of sulfur compounds by bacteria; subrio. vibrio.

Slightly curved rode of variable length, usually occurring singly but sometimes in short chains which have the appearance of spirilla. Swollen pleomorphic forms are common. Actively motile by means of a single polar flagellum. Strict anaerobes which reduce sulfates to hydrogen sulfide round in sta water, marine mud, fresh water, and soil

The type species is Desulforibrio desulfuricans (Beijerinck) Kluyver and van Niel.

Desulforthrio desulfuticans (Benjerinck) Kluyver and van Niel (Bacterium hydrosulfureum ponticum Zelinsky, Proc. Russ Phys and Chem. Soc , 25, 1893, 298, Spirillum desulfuricans Berierinck, Cent. f. Bakt., II Abt , 1, 1895, 1; Bacillus desulfuricans Saltet, Cent. f. Bakt., II Abt., 6, 1900, 648; Microspira desulfuricans Migula, Syst d. Bakt , 2, 1900, 1016; Kluyver and van Niel, Cent. f. Bakt, II Abt, 94, 1936, 369, Vibrio desulfuricans Holland, Jour. Bact., 5, 1920, 225, Spororibrio desulfuricans Starkey, Koninkl. Nederland Akad. v. Wetenschappen, Proc., 41, 1938, 425; also in Arch f. Microbiol., 9, 1938, 268.) From M L present part desulfurico, sulfur reducing.

Slightly curved rods, 0.5 to 1.0 by 1 to 5 microns, usually occurring singly but sometimes in pairs and short chains which cause them to look like spirilla. Swollen pleomorphie forms are common. Older cells appear black due to precipitated ferrie sulfide. Actively motile, possessing a polar fagellum Gramnegative. Stains readily with carbol fuchsin.

Grows best in freshwater media, Fails to develop in sca water upon initial isolation

Produces opalescent turbidity in absence of oxygen in mineral media enriched with sulfate and peptone.

Media containing iron salts blackened. Bacteris found associated with precipitated ferrous sulfide.

Peptone-glucose agar colonies (in absence of air): Small, circular, slightly raised, dull, entire, soft in consistency.

Gelatin not liquefied

Peptone, asparagine, glycine, alanine, aspartic acid, ethanol, propanol, butanol,

Prepared by Dr. Claude E. ZoBell, Scripps Institution of Occanography, La Jolla, California, Jan., 1943.

glycerol, glucose, lactate, succinate and malate known to be utilized as hydrogen donors.

Produces up to 500 ml. H<sub>2</sub>S per liter Nitrites not produced from nitrates.

Reduces sulfate to hydrogen sulfide. Also reduces sulfites, sulfur, thiosulfates and hyposulfites.

Optimum pH 6 to 7.5, limits pH 5 to 9
Optimum temperature 25 to 30° C.
Maximum 35 to 40° C.

Anaerobic.

Habitat: Soil, sewage, water.

2 Desulfovibrio aestuarii (van Delden) comb nov (Microspira aestuarii van Delden, Cent f. Bakt, II Abt, II, 1904, SI; Yibrio desulfurcans (halophilic strain) Baars, Over Sulfaatreductie door Bakterien, Diss Delft, 1930, 164 pp.) From Latin, aestuarium, estuary

Morphologically indistinguishable from Desulforubrio desulfuricans described above, although it has a greater tendency to pleomorphism, and is slightly larger. Motile, possessing a polar flagellum. Gram-neartive

Grows preferentially in media prepared with sea water or 3 per cent salt minoral solution enriched with sulfate and peptone. According to Baars (lee et!) the marine species can be acclimatized to tolerate hypotomic salt solutions but Rittenberg (Studies on Marine Sulphate-Reducing Bacteria, Thesis, Univ. of Calif, 1941, 115 pp.) was unable to confirm this observation. Likewise Rittenberg was unable to acclimatize D. actuary to tolerate temperatures exceeding 45° Co rt o produce endospores.

Produces faint turbidity in absence of oxygen in sea water enriched with sulfate and peptone Organisms most abundant in sediment

Agar colonies Small, circular, slightly raised, darker centers, entire, soft consistency.

Gelatin not liquefied.

Peptone, asparagine, glycine, alanine, glucose, fructose, ethanol, butanol,

glycerol, acetate, lactate and malate known to be utilized in presence of sulfate.

Reduces sulfate to hydrogen sulfide. Also reduces sulfites, sulfur, thiosulfates and hyposulfites.

Produces up to 950 ml. H<sub>2</sub>S per liter. Nitrites not produced from nitrates.

Optimum temperature 25° to 30° C. Maximum 35° to 40° C.

Optimum pH 6 to 8, limits pH 55 to

Anaerobic.

Habitat: Sea water, marine mud, brine and oil wells.

3. Desulfovibrio rubentschickii (Baars) comb. nov. (Vibrio rubentschickii Baars, Over Sulfaatreduction door Bakterien, Diss. Delft, 1930, 164 pp.) Named for L. Rubentschick.

Slightly curved rods, 0.5 to 10 by 1 to 5 microns, usually occurring singly, sometimes in pairs and short chains. Actively motile, possessing a polar flagellum. Gram-negative. Morphologically indistinguishable from Desultantial of the property of the substantial property of the sub

Reduces sulfate to hydrogen sulfide Also reduces sulfites, sulfur, thiosulfates

and hyposulfites.

Culturally and physiologically like D. desulfuricans except that D. rubeni-schickii tulikes propionic acid, butyric acid, valeric acid, palmitic acid, staric acid, galactose, sucrose, lactose and maltose.

Anaerobic.

Habitat: Soil and ditch water.

Appendix: The following species has also been regarded as belonging in this genus.

Vibro thermodesulfuricans Eloa (Cent I. Bakt., II Abt., 63, 1921, 53), Vibrio desulfuricans (thermophilic strain) Baars, Over Sulfantreductie dor Bakternen, Diss. Dellit, 1930, 164 pp; Sporosibrio desulfuricans Starkey (Konink). Nederland. Akad. u Wetenschappen, Proc., 41, 1938, 425, also see Arch. f. Microbiol., 9, 1938, 268.) A thermophilie sulfate-reducing anaerobe which grows at 30 to 65°C, and which, according to Starkey, produces endospores. Elion described Vibrio thermodesulfuricans (Cent. f. Bakt., II Abt., 63, 1924, 58) which grows at temperatures no lower than 30 to 40°C, and has an optimum of 55°C. Morphologically it is much like Desulfovibrio desulfuricans and D. aestuaris although the thermophilic form is shorter, more rod-like, less motile and more pleomorphic. According to Baars (loc. cit ), Vibrio thermodesulfuricans Elion can be acclimatized to grow at lower temperatures and it is found abundantly in environments where the temperature has never been as high as 30°C. This observation is confirmed by Starkey (Arch. f. Microbiol, 9, 1938, 268) who found further that the thermophilic form found in nature or developed by acclimatization to higher temperatures

produces endospores. However, sporeformation appears to be the exception rather than the rule The pleomorphic, peritrichous, sporogenous, reducer is more rod-like than the asporogenous cultures and many cells of the sporogenous cultures are Gram-positive whereas asporogenous cultures of Desulfovibrio desulfuricans are Gram-negative. all of which leaves a question whether the sporogenous sulfate-reducer is a Racillus or a Desulfovibrio. Rittenberg (Studies on Marine Sulfate-reducing Bacteria, Thesis, Univ. Calif., 1941, 115 pp.) was unable to adapt the marine sulfate reducer to grow at low salinities or at high temperatures, nor could it be induced to form spores.

Desulforibrio halohydrocarbonoclasticus Zobell (U. S. Patent No. 2,413,278; Science News Letter, Jan. 11, 1947) From oil bearing rocks

#### Genus III. Cellvibrio Winogradsky.\*

(Ann. Inst. Pasteur, 45, 1929, 577) From M. L. cell, an abbreviation for cellulose, tibrio, vibrio.

Long slender rods, slightly curved, with rounded ends, show deeply staining granules which appear to be concerned in reproduction. Monotrichous Most species produce a yellow or brown pigment with cellulose. Oxidize cellulose, forming oxycellulose. Growth on ordinary culture media is feeble Found in soil.

The type species is Cellubrio ochraceus Winogradsky.

#### Key to the species of genus Cellvibrio.

- No growth on glucose or starch agar.
   Ochre-yellow pigment produced on filter paper.
  - 1. Cellvibrio ochraceus.
- II. Growth on glucose and starch agar
  - A. Poor growth on starch agar.
    - Cream-colored pigment which becomes brown with age is produced on filter paper.
      - Cellvibrio flavescens.
  - B. Abundant growth on starch agar.
    - 1. Scanty growth on glucose agar
      - a Intense yellow pigment produced on filter paper.
        - 3. Celleibrio fuleus
    - 2 Abundant growth on glucose agar, a No pigment produced on filter paper,
      - 4. Cellribrio vulgaria.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, Sept , 1937; no change. July, 1943.

 Cellvibrio ochraceus Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 549, 601.)
 From Greek, 6chra, yellow ochre; M. L. like ochre, yellow.

Plump, curved rods with rounded ends, 2.0 to 4.0 microns long, rarely occurring as spirals. Chromatic granule frequently found in center. Motile with a single flagellum. Gram-negative.

Produces diffuse, light ochre-colored, mucilaginous colonies on cellulose silica gel medium.

No action or growth on plain agar. No growth on peptone, glucose, starch or tragacanth gum agar.

Filter paper streaks: Entire paper colored ochre-yellow in 48 hrs.

Aerobic, facultative.

Optimum temperature 20°C.

Distinctive character Rapid ochrecolored growth.

Habitat Soil. Disintegrates vegetable fibers.

2 Cellvibrio flavescens Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 608) From Latin, part. adj. of flavesco, to turn yellow or golden.

Plump, curved rods, flexuous, with rounded ends, 0 5 by 2 5 to 5.0 microns. Shows metachromatic granules. Motile with a single flagellum Gram-negative.

Produces diffuse, cream-colored growth becoming brownish; mucilaginous colonies on cellulose silica gel medium.

Good growth on peptone agar. Colonies 1 mm in 4 days. Grows poorly on glucose, starch and gum agars

Filter paper streaks: Almost as rapid in growth as *Cellvibrio ochraceus* and colors entire paper in 2 to 3 days.

Aerobic, facultative

Optimum temperature 20°C.

Distinctive characters. Smaller, less curved rods that grow on a greater variety of media than *Cellvibrio ochra*ceus, but do not attack cellulose as readily.

Source: Isolated from a pile of old damp sawdust.

Habitat: Soil. Disintegrates vegetable fibers.

Cellvibrio fulvus Stapp and Bortels.
 (Culture Y, Dubos, Jour. Bact., 15, 1928, 230; Stapp and Bortels, Cent. f. Bakt., II Abt., 90, 1934, 42.) From Latin, fulvus, reddish vellow.

Slightly curved rods: 03 to 0.4 by 1.5 to 30 microns. Show involution forms. Motile by means of a single polar flagellum. Gram-negative.

Cellulose is decomposed. Grows on filter paper with an intense egg-yellow color which in older cultures may deepen to rust brown.

Glucose agar: Very scanty growth. Sucrose agar: Very slight growth.

Sucrose agar: Very slight growth.

Maltose agar: Abundant yellow growth.

Lactose agar: Fairly abundant yellow growth.

Starch agar: Very abundant, bright yellow growth which later turns brown. Nutrient broth: No growth.

Temperature relations: Optimum 25° to 30°C. Minimum 5°C. Maximum 32° to 35°C. No growth at 37°C. Thermal death point 39° to 40°C.

Aerobic.

Source: Isolated from forest soil in Germany and from soil in the United States.

Habitat: Widely distributed in soils.

4. Cellvibrio vulgaris Stapp and Bortels. (Culture Co, Dubos, Jour-Bact., 16, 1928, 230; Stapp and Bortels, Cent. f. Bakt., II Abt., 90, 1934, 41.) From Latin, vulgaris, common.

Curved rods: 0.3 by 2 9 to 4.0 microns. Shows involution forms, Motile by means of a single polar flagellum. Gramnegative.

Cellulose is decomposed. Grows on filter paper without the formation of pigment.

Glucose agar: Abundant growth. No

Sucrose agar: Abundant slightly yellow growth.

Maltore agar: Abundant yellowish arowth.

Lactore agar: Very heavy growth Starch agar: Very abundant yellowish rowth.

Nutrient broth: No growth

Temperature relations: Optimum 25° to 30°C. Minimum 5°C. Maximum 32°

to 35°C. No growth at 37°C. Thermal death point 41° to 45°C.

Armbie.

Source. Isolated from forest soil in Germany and from soils in the United States

Habitat Widely distributed in soils

#### Genus IV Cellfalcicula fi inografiky

(Ann. Inst. Pasteur, 43, 1929, 616). From M. L. cell, an abbreviation for rellulose; Latin dim. Jalcievia. a small siekle.

Short role or spindles, not exceeding 2.0 micrors in length, with pointed ends, containing metachromatic granules. Old cultures above exceed forms. Monattrichems. Oil fire collubor, forming ony cellulate. Growth on ordinary culture media is feelile. Soil betteris.

The type species in Cellfaleicula siri fir Wirreraleky

1. Celifalcicula viridia Winogradska (Ann. Inst. Pastrur, 45, 1923, 616.) I rom Latin, siridis, giren,

Plump, small spinites, 97 by 20 mierons, with nounded ends Motile with spinele fixedium. Gram negative

Prefuces diffuse green, muchanismas

Filter paper streaks. Bapid spread or growth reduced green in 3 dies at 20°C. Hydrocettal see agest. Growth rapid, green, ventale yellowish green, view as

en' mission streking Nagmusthun peptone, glunue, statch et sum ams

Arrive, Involtation

Optimism temperature 2011. Hafatet Kal

2. Cellfalificala mucosa Miregraficka efent from Pasterie, 25, 2003 (22.) Teles Latin, microsco, 2, 2003

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Na growth on popiose, glucose,

Aember, facultation

Operation temperature 20°C. Habitat fool

3 Celifaltitula futta Wingrably (Ann Irst Pesteur 48 1920 (521) Fuen Latin forcis dark tanny

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<sup>.</sup> The selected to the finance of the whole over the well-reading energy. The winds the first, and the second of th

#### Genus V. Thiospira Vislouch.\*

(Jour de Microbiologie, 1, 1914, 50; Sulfospirillum Kluyver and van Niel, Cent. f. Bakt., II Abt., 94, 1936, 396.) From Greek, theion, sulfur; speira, coil.

Colorless, motile, slightly bent rods, somewhat pointed at the ends, with granules of sulfur within the cells and a small number of flagella at the ends.

The type species is Thiospira winogradskyi (Omelianski) Vislouch.

 Thiospira winogradskyi (Omelianski) Vislouch. (Thiospirillum winogradskyi Omelianski, Cent. f. Bakt., II Abt., 14, 1905, 769; Thiospirillum granulatum Molisch, Cent. f. Bakt., II Abt., 53, 1912, 55; Vislouch, Jour. de Microbiologie (Russian), I, 1914, 50; Sulfospirillum winogradskyi Kluyver and van Niel, Cent f Bakt., II Abt., 94, 1936, 397) Named for Winogradsky, the Russian bacteriologist.

Large, sulfur sp rilla, somewhat pointed at the ends, 2 to 25 microns thick, to 50 microns long. Numerous granules of sulfur Very motile, with one to two polar flagella

Habitat: Curative mud.

Thiospira bipunctata (Molisch)
 Visiouch. (Spirillum bipunctatum Molisch, Cent. I. Bakt., II. Abt., 53, 1912,
 Visiouch, Jour. de Microbiologie (Russian), I. 1914, 50.)
 From Latin, bi, two; punctum, points.

Small, slightly bent sulfur spirils, markedly pointed at the ends, 6 6 by 14 microns long, 1.7 to 2.4 microns wide (in the center of the cell). Both ends are filled more or less with large volutin (metachromatic) granules. Several minute granules of sulfur are present in the clear center and sometimes at the ends. Old cells possess one flagellum at each end; young cells have a flagellum at one end.

Habitat: Sea and salt waters.

#### Genus VI. Spirillum Ehrenberg.

(Ehrenberg, Abhandlungen d. Berl. Akad., 1830, 38; Spirosoma Migula, Arb. bakt. Inst. Karlsruhe, 1, 1894, 237; Dierospirillum Enderlein, Sitzber. Gesell. naturf. Freunde, Berlin, 1917, 313.) From Greek, speira, a spire or coll.

Cells form either long screws or portions of a turn Volutin granules are usually present. Usually motile by means of a tuft of polar flagella (5-20) which may occur at one or both ends of the cells. Aerobic, growing well on ordinary culture media, except for one saprophyte and the pathogenic species. These have not yet been cultivated. Usually found in fresh and salt water containing organic matter.

The type species is Spirillum undula (Muller) Ehrenberg.

#### Key to the species of genus Spirillum.

- One micron or less in diameter.
  - Volutin granules present,
    - a. Slow to rapid liquefaction of gelatin.
      - b Grayish to brown growth on potato.
        - Spirillum undula.

<sup>•</sup> Prepared by Prof. D. H. Bergey, Philadelphia, Penn., October, 1922. † Revised by Prof. D. H. Bergey, Philadelphia, Pennsylvania, April, 1937; further revision by Prof. Robert S. Breed, New York State Experiment Station, Genera, New York, June, 1943, based on Monograph by Giesberger, Inaug. Diss., Utrecht, Nov. 30, 1936.

- bb. Light yellowish-orange growth on potato.
- Spirillum serpens.
   No liquefaction of gelatin Of small size (0.5 micron in diameter).
- b. Colonies on agar white becoming brownish black and slightly wrinkled
  - Spirillum itersonii
  - bb. Colonies on agar white and smooth.
    4. Spirillum tenue,
- No volutin granules observed.
   b. Single flagellum
  - bb. Tuft of flagella
- Spirillum virginianum.
   Spirillum minus.
- II. Over one micron in diameter.
  - 1. Grows poorly on peptone sgar and potato.
  - 7. Spírillum kulseheri.
  - Not positively known to have been cultivated on artificial media. Very
    evident volutin granules
     Spirillum volutans.
  - 3. Cells more or less deformed by fat drops.
    - Spirillum lipoferum.
- Spirillum undula (Müller) Ehrenreg. (Vibrio undula Müller, Animalila infusoria et marina, 1786; Ehrenberg, ifusionstierchen, 1838; Spirillum udula minor Kutscher, Cent I. Bakt., Abt., 18, 1895, 614.) From Latin,

ndulatus, wave-like.

Stout threads, 0.9 micron in diameter, ith one-half to three turns. The wave ngths are 6 microns. Width of spiral,

O microns. Tufts of three to nine agella at each pole. Volutin granules resent. Gram-negative.

Gelatin colonies: The surface colonies re circular, granular, greenish-yellaw, ntire

Gelatin stab: Tluck, white, rugose urface growth Very slow liquefaction. Agar colonies: Grayish-white, smooth Broth: Turbid.

Potato: Grayish-brown growth.

Indole not formed Catalase positive.

Nitrites not produced from nitrates. Acrobic, facultative.

Optimum temperature 25°C.

Cohn (Beltrage z. Biol. d Pflanzen, I, left 2, 1975, 132) reports that he could

not distinguish this organism from Vibrio prolifer Ehrenberg.

Habitat. Putrid and stagnant water.

 Spirilium serpens (Müller) Winter. (Vibrio serpens Müller, Animalcula infusoria et marina, 1786, 43; Winter, in Rabenhorst's Kryptogamen-Flora, 1, Die

Rabenhorst's Kryptogamen-Flora, 1, Die Pilze, 1884, 63) From Latin, serpens, serpent Long, curved rods with two to three wave-like undulations, 0 8 to 10 micron

wave-rise undeathors, or 10 increase, in diameter; wave length, 8 to 9 microns, Width of spiral 15 to 1.8 microns. Volutin granules in cytoplasm. Motile, possessing tufts of flagella at both poles. Gram-negative

Gelatin colonies: Yellowish to brownish, granular, entire.

Gelatin stab: Yellowish surface growth. Slow liquefaction

Agur colonies: Heavy cream-colored

growth.

Agar slant: Grayish, with yellowish center, granular, entire.

Broth: Turbid.

Litmus mill. Unchanged. Potato: Clear orange-yellow growth

Indole not formed.

Catalase positive.

Nitrites not produced from nitrates.

Aerobic, facultative.

Optimum temperature 35°C. Habitat: Stagnant water.

3. Spirillum itersonii Giesberger. (Inaug Diss, Utrecht, 1936, 46 and 57.) Named for van Iterson, the Dutch bacteriologist.

The smallest of the spirilla isolated from water. First observed by van Iterson (Proc. Kon. Akad v. Wetensch. Amsterdam, 5, 1902, 685).

Small spirals, 0.5 micron in diameter. Wave length, 3 to 3.5 microns. Spiral width, 1 to 1.5 microns. Motile with bipolar tufts of flagella. Gram-negative.

Grows readily on peptone agar. White colonies becoming brownish black, and slightly wrinkled

Gelatin stab No liquefaction

Brownish-orange growth on potato. Volutin granules may be present.

Catalase is produced.

Acid from glucose, fructose, ethyl alcohol, n-propyl alcohol, n-butyl alcohol, and glycerol Utilizes acetic, propionic, n-butyric, tartane, fumaric, laetic, citric, and succinic acids.

Grows well in peptone broth Also utilizes ammonia compounds.

Anaerobic growth in the presence of nitrates when organic or ammonia nitrogen is also available.

Optimum temperature · 30°C. Source Isolated from water Habitat · Water.

Spirillum tenue Ehrenberg. (Infusionstierchen, 1838; see Bonhoff, Arch f Hyg, 26, 1896, 162) From Latin, tenuis, thin

Slender spirals Diameter 0.7 micron. Wave lengths 4 5 to 5 0 microns Width of spiral 1 5 to 1 8 microns.

Actively motile in peptone water with tufts of flagella at each pole. Volutin granules present. Gram-negative.

Agar colonies White, smooth.

Peptone agar slant : Heavy growth.

Gelatin stab : No liquefaction.

Catalase positive.

Potato: Light brown growth.

Acid from glucose and fruetose Slight acid from several other sugars and glycerols. Utilizes salts of acetic, propionic, n-butyric, tartaric, lactic, citric, malic, and succinic acids.

Ammonia compounds are used as a source of nitrogen.

Optimum temperature, 30°C.

Source: Found in putrefying vegetable matter.

Habitat; Putrefying materials.

 Spirillum virginianum Dimitroff. (Jour. of Bact., 12, 1926, 19.) From M. L. genitive of Virginia.

Spirals consisting of \( \frac{1}{2} \) to 3 complete turns in young cultures, older cultures showing 7 turns. 0.6 to 0.9 by 3 to 11 microns. Motile with a single polar flagellum on one or both ends. Gramnegative.

Gelatin colonies: Entire, convex, circular, moist, colorless.

Gelatin stab: Growth along entire stab No liquefaction. (Dimitroff, loc. etl.) Active liquefaction. (Giesberger, Inaug Diss., Utrecht. 1936, 65.)

Agar colonies: Dew drop, convex, entire, moist, colorless.

Agar slant: Dew drop, isolated colonies Broth: Cloudy, no flocculation.

Uschinsky's protein-free medium: Abundant growth.

Litmus milk: No growth.

Loeffler's blood serum: Convex, isolated dew drop colonies. No lique-faction.

Lead acetate agar: No H2S.

Voges-Prosknuer and methyl red negative.

No volutin granules observed (Giesberger, loc. cit., p. 60).

Potato: No growth

Indole not formed.

Nitrites not produced from nitrates

No acid or gas from carbohydrates.

(Dimitroff, loc. cit.). Utilizes lactates and citrates (Giesberger, loc. cit.) Aerobic, facultative.

Optimum temperature 35°C.

Source: Isolated from mud on an oyster

Habitat. Probably muddy bottom of brackish water.

Spirillum minus Carter. (Carter, Sei Mem. Med. Officers Army India, 5, 1887, 45; Spirillum minor Carter, ibid.; Spirochaeta laverant Breinl and Kinghorn, Mem. Laverpool Sch. Trop Med , 21, 1906, 55; Spirochaeta muris Wenyon, Jour Hyg., 6, 1906, 580, Spirochaeta muris var virginiana MacNeal, Proc Soc. Exper. Biol. and Med , 4, 1907, 125; Spirochaeta muris var. galatziana Mezincescu, Compt. rend. Soc Biol Paris, 66, 1909, 58: Treponema muris Moore, Principles of Microbiology, 1912, 414, Spirochaeta morsus muris Futaki, Takaki, Taniguchi and Osumi, Jour Exp Med, 25, 1917, 33; Spirochaeta petit Ron, Ind Jour. Med. Res., 5, 1917, 386, Spironema muris Noguchi, Jour. Exp. Med , 27, 1918, 584; Spirochaeta japonica Duiarrie de la Rivière, Ann de Méd , 5, 1918, 181; Spirochaeta morsusmuris Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 117; Spiroschaudinnia morsusmuria Castellani and Chalmers, abid , Spirochacta sodoku Trossier, 1920, according to Pettit, Contribution A l'Étude des Spirochétides, Vanves, II, 1928, 231, Treponema japonicum Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 505, Treponema morsus muris Brumpt, abid , 506; Treponema minor Brumpt, ibid , 307; Treponema larerani Brumpt, ibid . 507; Treponema sodoku Brumpt, ibid . 511; Spirochaeta pettiti Row, Jour Trop Med. and Hyg., 25, 1922, 361, Treponemella murie San Giorgi, Patho logica rivista, 14, 1922, 161; Borrelia muris Bergev et al., Manual, 2nd ed., 1925, 435; Spirillum minus var, moreus muris Ruys, Cent. f. Bakt , I Abt , Orig , 101, 1927, 270; Spirillum minus var. muris Ruys, ibid; Spironema minor Ford, Textb. of Bact., 1927, 962; Spironema laverani Ford, ibid., 963; Spironema muris var. virginiana Ford, ibid., 963; Spirella morsusmuris Noguchi, in Jordan and Falk, Newer Knowledgo Bact and Immun., 1928, 497; Spirella muris Noguchi, ibid) From Latin, minus, less.

Description taken from Adachi, Jour. Exp Med., 33, 1921, 647 and Giesberger, Inaug Diss., Delft, 1936, 67.

Short thick cells 0.5 by 3.0 microns, having 2 or 3 windings which are thick, regular and spiral. Actively motile by means of bipolar tufts of flagella. Gramnegative.

Has not been cultivated on artificial media

Aerobic, facultative.

Pathogenic for man, monkeys, rats, mice and guinea pigs

This species is regarded by some as a spirochaete. Because of its habitat and wide distribution it has been described under many different names It is possible that some of these names indicate varieties or even separate species. See Beeson (Jour. Amer. Med. Assoc., v23 1032 23) for insportant therature.

123, 1943, 332) for important literature.
Source Found in the blood of rats and

Habitat The cause of rat-bite fever. Widely distributed.

7 Spirillum kutscheri Migula. (Spirillum undula majus Kutscher, Cent. f Bikt. I Abt., 18, 1895, 614; Migula, Syst. d. Bakt., 2, 1900, 1021) Named for Kutscher, the German bacteriologist who first isolated the organism

Stout threads, 1.5 microns in drameter. Wave lengths 10.5 to 12.5 microns. Width of spiral, 3 to 4.5 microns. May lose their spiral form on continued cultivation. Motile with tufts of fagella at the poles. Gram-negative.

Gelatin colonies: Transparent, round, surface colonies. Deep colonies, dark brown. Gelatin stab: Slow liquefaction.

Agar colonies grow poorly, granular. Deep colonies yellowish-green to dark brown.

Agar slant: Delicate, transparent growth.

Potato: Limited growth.

Volutin present.

Catalase positive.

Utilizes malic and succinic acids.
Grows well on peptone broth. Also utilizes ammonia compounds.

Optimum temperature, 22° to 27°C. Source: Isolated from putrid materials and liquid manure.

Habitat: Putrefying liquids.

 Spirilium volutans Ehrenberg. (Prototype, Vibrio spirilium Muller, Animalcula infusoria, 1786; Ehrenberg, Die Infusionstierchen als Volkommene Organismen, 1838)

Spirals 1.5 microns in diameter. Wave length, 13 to 15 microns, width of spiral, 4 to 5 microns. The largest of the spirilla Slightly attenuated ends. Motile, possessing a tuft of ten to fifteen flagella at each pole. Dark granules of volutin in the cytoplasm. Gram-negative.

Migula (Syst. d. Bakt, 2, 1900, 1025) reports that this species has not been cultivated on artificial media, and that the cultures so described by Kutscher (Ztschr. f. Hyg., 20, 1895, 58) are of a different species which Migula names Spirillum giganteum. Vahle (Cent. f. Bakt., II Abt., 28, 1910, 237) Later describes the cultural characters of an organism which he regards as identical with Kutscher's organism. Gleisberger (Inaug. Diss., Delft, 1936, 65) saw what he felt was the true Spirillum volutans but could not cultivate it.

Optimum temperature 35°C Habitat: Stagnant water. 9. Spirillum lipoferum Beijerinci, (Azolobacter spirillum Beijerinck, Kon. Akad. Wetensch. Amsterdam, 30, 1923, 431 quoted from Giesberger, Inaug. Diss., Delft, 1936, 24; Spirillum lipoferum Beijerinck, Cent. f. Bakt., Il Abt., 63, 1925, 353; Chromatium lipoferum Bergey et al., Manual, 3rd ed., 1930, 531.) From Greck, lipos, fat; Latin, fero, to bear.

Curved cells with one-half to one spiral turn, containing minute fat droplets. These may deform the cells, Motile with lophotrichous flagella. Gramnegative.

Calcium malate agar colonies: Circular, small, transparent, dry. The malate is oxidized to calcium carbonate. Cells contain fat drops.

Peptone agar colonies: More abundant development. Cells lack fat drops and are typically spirillum in form.

Glucose peptone broth: Cells actively motile with large fat drops.

Fixes atmospheric nitrogen in partially pure cultures, i.e., free from Azolobaciand Clostridium (Beijerinek, loc. cit.). Schröder (Cent. f. Bakt., II Abt., 85, 1932, 17) failed to find fivation of nitrogen when she used cultures derived from single cell.

Aerobic.

Optimum temperature 22°C.

Beijerinck regards this as a transitional form between Spirillum and Azotobacter. Giesberger (loc. cit., p. 64-65) thinks it a Vibrio.

Habitat: Garden soil.

Appendix: The following additional species have been mentioned in the literature. Many are inadequately described. Some may not belong here.

Prepared by Mr Wm. C. Haynes, New York State Experiment Station, General New York, Jan., 1939; Revised by Capt. Wm C. Haynes, Sn. C., Fort Bliss, Tetas July, 1943.

Spirella can's Duboseq and Lebailly (Compt rend. Acad Sci. Paris, 154, 1912, 835.) From the stomach of a doc.

Spirillum ampliferum Van Tieghem (Bull. Soc. botan. de France, 26, 1879, 65) Said to produce spores Ford (Textb. of Bact., 1927, 361) thinks this organism was probably a spirochaete because of its mode of division. Found in frog spawn funcus of sugar factories

Spirillum attenuatum Warming (Om nogle ved Danmaris Kyster levende Bakterier. Kjobenhavn, 1876; Spirosoma attenuatum Nigula, Syst. d. Bakt., 2, 1900, 959. Ford (bor. ci, 363) attasthat this incompletely described organism would now be regarded either as a spirillum or as a spirochaete From sea.

coast of Denmark.

Spirillum cardiopyrogenes Sardjito (Geneesk. Tijdschr voor Ned -Indie, 72, 1932, 1359; ibid., 73, 1933, 822.) From blood of a patient with pericarditis

Spirillum colossis Errera (Rec trav bot. Bruvelle, 5, 1902; Abst in Cent f Bakt., II Abt., 9, 1902, 608) A giant form isolated from brackish sea water Probably the same as Spirillum rolutans Chrenberg.

Spirillum concentricum Kitasato. (Cent f. Bakt., 5, 1888, 73) Found in putrefying blood.

Spirillum crassum Veillon and Repaci. (Ann. Inst. Past., 26, 1912, 300) Described as having peritrichous flagella From lung lesions in human tuberculosis

Spirillum endoparagogicum Sorokin. (Cent. f. Bakt., 1, 1887, 465) Described as producing spores in old cultures. From rain water in bark of poplar tree. Spirillum giganteum Migula. (Spiril-

lum volutans Kutscher, Ztschr f Hyg., 20, 1895, 58; Migula, Syst d. Bakt., 2, 1900, 1025.) From putrefying liquids

Spirillum hachaitae Kowalski. (Cent f. Bakt., 16, 1891, 321; Spirillum hachaitcum Kowalski, ibid., 321; Spirochaeta hachaitae Castellani and Chalmers, Man. Trop. Med., 1st cd., 1910, 316; Treponema hachaizae Brumpt, Nouveau Traité de Médecine, Paris, 4, 1922, 495.) Found in feces of cholera patients and also of healthy individuals.

Spirillum kolkwitzii Vislouch. (Jour. de Microbiol. (Russian), 1, 1914, 50.)

Sprillum leucomclaenum Perty. (Zur Kenntniss kleinster Lebensformen. Berne, 1852. Also see Koch, Mitt. Kais. Gesundheitsamte, 1, 1881, 48.) From stagnant water.

Spirillum monospora Dobell. (Quart. Jour. Micr. Sci., 52, 1908, 121.) Described as producing spores. From large intestine of frogs and toads.

Spirillum nigrum Rist. (Thèse méd , Paris, 1898; see Cent. f. Bakt., I Abt., 39, 1901, 299) Strict anaerobe from pus. Spirillum ostreae Noguchi. (Jour.

Exp. Med., 54, 1921, 295.) From oysters. Spirillum periplancticum Kunstler and Gineste (Compt. rend. Soc Biol Paris, 61, 1906, 135.) From the intestine

of the cockroach, Periplanela americana.
Spirillum pyogenes Mexincescu.
(Cent. f. Bakt, 1 Abt, Orig, 35, 1904,
201; Spirochaeta pyogenes Blanchard,
Semaine Méd. 25, 1906, 15, Treponema
pyogenes Brumpt, Nouveau Traité de
Médeeune, Paris, 4, 1922, 511) From a
case of pyeltic acludosa.

Spirillum rappin: De Toni and Trevisan. (Spirochaete, Rappin, Contr. à l'Étude d. Bactér. de la Bouche à l'État normal, 1881, 68; De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889,

1009) From the stomach of a dog. Spirillum recti physeteris Beauregard (Compt. rend. Acad. Sci. Paris, 125,

1597, 255.) From ambergris.

Sprullum rugula (Müller) Winter. (Vlobio rugula Müller, Anmaleula influsoria, 1786; Cohn, Beitrage z. Biol. d. Pflanz, f. Heft 2, 1872, 178; Bonhoff, Arch. f. Hyg., 26, 1896, 162; Winter, Die Pilre, in Rabenhorst's Kryptogamen-Flora, 1881.) Framowski found spores, but it is not certain his cultures were pure. Boahoff also observed spores, but

concluded that they were due to contaminating organisms (Ford, Textb. of Bact., 1927, 360). From water.

Spirillum sporiferum Migula. (Syst. d. Bakt., 2, 1900, 1028.) Produces spores. The spirals in which the spore formation is beginning are like Spirillum leucomelaenum Perty (Ford, loc. cit., 336). Giesberger (loc. cit., p. 60) places this and other so-called spore-forming spirilla in Sporospirillum Orla-Jensen (Cent. f. Bakt., 11 Abt., 22, 1909, 340). From a bean infusion.

Spirillum sputigenum Miller, (Die Mikroorganismen der Mundhohle. Leinzig. 1892, Deutsche med. Wchnschr., 32, 1906, 1 and 348.) Hoffman and Prowazek (Cent. f. Bakt, I Abt, Orig, 41, 1906, 741) claim that Spirillum sputigenum has peritrichous flagella. Giesberger (loc. cit. 63) places this in Sclenomonus Prowazek (Cent f. Bakt., I Abt., Orig., 70, 1913, 36). Muhlens (Cent. f Bakt., I Abt., Orig., 48, 1909, 525) reports 1 to 3 flagella, the majority of the organisms having apparently a single thick flagellum (a bunch of flagella) on the concave side (Ford, loc cit, 367). Anaerobic. From the buccal cavity

Spirillum stomach: Lehmann and Neumann. (Spirillum Form  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ Salomon, Cent f Balt, I Abt, 19, 1896, 433; Lehmann and Neumann, Bakt Diag, 2 Aufl, 2, 1899, 362) Found in stomach of dog, cat and rat

Paraspirillum vejdovskii Dobell. (Arch f Protistenk, 24, 1911, 97) Found only once in fresh water containing Oscillatoria. Flagellate flevible spiral cells described as possessing a nucleus. This may be a protozoan.

Spirobacillus gigas Certes. (Bull. Soc Zool. France, 14, 1889, 322; abst. in Ann. de Microgr., 2, 1889–1890, 137.) From

Vibriothrix tonsillaris Tunnicliff and Jackson. (Organism from Actinomyces-like granules, Tunnicliff, Jour. Inf. Dis, 58, 1926, 366; Tunnicliff and Jackson, ibid., 40, 1930, 12) From tonsillar granules. May be identical with Leptothrix asteroide Mendel and as a Gramnegative, annerobe may belong in Bacteroides according to Rosebury (Bact. Rev., 8, 1914, 202).

Vibriothrix zeylanica (Castellanı) Castellani. (Spirillum zeylanicum Castellani Jour. Ceylon Branch Brit. Med. Assoc., 7, 1910, 5 and Philipp. Jour. Sci., 5, No. 2, Sect. B., Medical Sciences, July, 1910: Vibrio zeulanicus Castellani, 1913, Bacillus zeylanicus Castellanı, 1913 and Vibriothrix zeulanica Castellani, 1917, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1069; Spirobacillus zeylanicus Castellaui, Spagnuolo and Russo, Bull, Soc. Path. Exot., 11, 1918, 271.) Motile. Gramnegative. From cases of dysenteric enteritis in Ceylon. This is the type species of the genus Vibriothrix Castellani (see Castellani and Chalmers, loc. cit. 1068).

# FAMILY III. AZOTOBACTERIACEAE BERGEY, BREED AND MURRAY. (Preprint, Manual, 5th ed., October, 1938, v and 71.)

Cells without endospores. Relatively large rods or even cocci, sometimes almost yeast-like in appearance. The type of flagellation in this genus has been definitely established as periturehous Gram-negative. Obligate aerobes, usually growing in a film on the surface of the culture medium Capable of fixing atmospheric nitrogen when provided with carbohydrate or other energy source Grow best on media deficient in nitrogen. Soil and water bacteria.

There is a single genus.

#### Genus I. Azotobacter Besierinck.

(Beijerinck, Cent. f. Bakt , II Abt , 7, 1901, 567; Asolomonas Orla-Jensen, Cent. f. Bakt., II Abt., 24, 1909, 444)

The definition is identical with that of the family. From Gr. azous, not living. French, azote, nitrogen, Gr baltron, rod, stick.

The type species is Azotobacter chroococcum Beijerinck

1 Azotobacter chrococcum Beyerinck. (Cent f. Bakt, II Abt., 7, 1901, 567 and 9, 1902, 3; Bacillus azotobacter Lohnis and Hanrawa, Cent. f. Bakt., II Abt., 42, 1914, 1; Bacillus chrococcus Buchanan, General Syst. Bact., Baltimore, 1925, 194.) From Gr. chroa, color; coccos, grain; M. L. sphere.

According to Löhnis and Smith (Jour. Agr. Res . 25. 1923, 401) Azotobacter beijerinchii Lipman (New Jersey Agr Exp. Sta. Rept., 25, 1904, 247), Azotobacter woodstownii Lipman (ibid ), Azolobacter smurnii Linman and Burgess (Cent. f. Bakt., II Abt., 44, 1915, 504) and Azotobacter hilgardii Lipman (Science, 29, 1909, 911) are identical with Azotobacter chroococcum, Greene (Soil Sci., 39, 1935, 327) studied Azotobacter chroococcum and Azotobacter benjerinckii by chemical analyses and found the chemical composition of the cells to be practically identical, but different from that of Azotobacter vinclandis and Azotobacter agile. Smith (private communication) feels that Azotobacter beijerinckis is a non-pigmented rough strain of Azotobacter chroococcum.

Grows in absence of organic nitrogen. Rods: 20 to 30 by 30 to 60 microns, occurring in pairs and packets and occasionally in chains. The cells show three or four refractile granules. The organisms are surrounded by a slmy membrane of variable thickness, usually becoming brownsh in older cultures, due possibly to the conversion of tyrosine to melanin The coloring matter is insoluble in water, alcohol, ether and chloroform Mothle by means of numerous peritrichous flagella (Hofer, Jour Bact., 47, 1914, 415) Gram-negative.

Gelatin colonies: Very small, circular, yellow, granular, later becoming yellowish-brown.

Gelatin stab. Only slight growth in the stab. No liquefaction

Mannitol agar stab. Gray, may become

Nutrient broth No growth even in the presence of glucose, peptone utilized with difficulty

Litmus milk Becoming clearer in 10 to 14 days.

Potato: Glossy, barely visible, slimy

<sup>\*</sup>Revised by Dr. A. W. Hofer, New York State Experiment Station, Geneva, New York, June, 1938; further revision by Dr. A. W. Hofer, July, 1943.

to wrinkled; may become yellowish, brownish-vellow or chocolate brown.

The organism fixes atmospheric nitrogen and gives off CO<sub>2</sub>, utilizing glucose and sucrose. Other generally used carbon compounds are fructose, maltose, mannitol, inulin, dextrin, galactose, arabinose, starch, glycerol, ethyl alcohol, acetate, butyrate, citrate, lactate, mainte, propionate and succinate.

Nitrate: Improves growth in amounts less than 1 gm. per liter, greater amounts are toxic.

Fives nitrogen moderately actively. Chemical analysis: Four-day cultures grown upon mannitol agar (Greene, 1935), when dried, are found to contain less than 0.5 per cent of hemicelluloses, less than 20 per cent of crude protein, less than 5 per cent of lignun-like materials. The nitrogen fraction contains less than 1 per cent of humin nitrogen and about 1 per cent of humin nitrogen and about 1 per cent of hesic nitrogen.

Aerobic

Optimum temperature 25°C. to 28°C. Distinctive characters: Inability to grow in peptone media, even in the presence of glucose, frequent occurrence of a dark brown or black pigment.

Source: Isolated from soil

Habitat: Occurs naturally in the majority of neutral or alkaline field soils

Azotobacter agile Beijerinck
 (Cent. f. Bakt., II Abt., 7, 1901, 577.)
 From L. agilis, agile, quick.

In studies on the chemical composition of cells Greene (Soil Sci., \$9, 1935, 327) found Asolobacter vinelandii Lipman (New Jersey Agr. Exp. Sta. Rept., 24, 1903, 238) to be very similar to Asolobacter agile Beijerinek. Smith and Löhnis (Jour. Agr. Res., 25, 1923, 401) agree and state furthermore that the two are identical; they believe also that Asolobacter vitreum. Löhnis and Westermann (Cent f. Bakt, II Abt., 22, 1908, 234) is another synonym of Asolobacter agile.

Smith (private communication) states that Azotobacter vitreum is a very weal growing, smooth strain of Azotobacter agite. Kluyver and van Reenen (Arch. Mikrobiol., 4, 1933, 299) feel that a distinction should be made between Azotobacter agite and Azotobacter vinelandii In regard to the former, Kluyver and van den Bout (Arch. Mikrobiol., 7, 1936, 263) suggest that it be further subdivided into Azotobacter agite and Azotobacter agite and Azotobacter agite and Azotobacter agite pand Azotobacter agite form that fails to produce piement.

spherical. Actively motile by means of numerous peritrichous flagella (Holer, loc. cit). Some strains are reported to be non-motile. Gram-negative.

Grows in absence of organic mtrogen.

Rods: 4 to 6 microns in length, almost

Gelatin: No liquefaction.

Mannitol agar colonies Circular, grayish white, translucent with whitish center.

Washed agar colonies: Show slight bluish-green fluorescence.

Mannitol agar slant: Grayish, translucent, fluorescent.

Plain agar slant: Yellowish-white, smooth, glistening, translucent with opaque center.

Broth: Turbid, with sediment. Litmus milk: Becoming clear in 10 to

14 days.
Potato: Yellowish-white, slumy, be-

coming yellowish-brown.

In the presence of organic acids, a

greenish or reddish pigment is formed The organism fixes atmospheric nitro-

gen actively, and gives off CO<sub>4</sub>.

Aerobic.

Chemical analysis: Four-day cultures grown upon mannitol agar (Green, 1935), when dried, contain more than 4 per cent of hemicelluloses, more than 45 per cent of crude protein, more than 7 per cent of ash, and less than 4 per cent of ligninlike materials. The nitrogen fraction contains more than 1 per cent amide mitrogen, more than 1 per cent humin nitrogen, and 2 per cent or more of basic nitrogen.

Optimum temperature 25°C to 28°C Distinctive characters. Lack of a brown pigment; occasional fluorescence; growth in peptone broth containing glucose.

Source: Originally isolated from canal water at Delft.

Habitat: Occurs in water and soil

3. Azotobacter Indicum Starkey and De. (Soil Sci. 47, 337, 1939) From L Indicus. of India.

Rods Ellipsoidal, from 0.5 to 1.2 by 1.7 to 2.7 microns when grown on nitrogen free glucos agar. One of the distinctive characteristics is the presence of two large, round, highly refractive bodies in the cells, one usually at each end. Motile by means of numerous peritrichous fagella (Hofer, loc. cit.). Gram-negative.

The organism grows slowly but in time produces large amounts of slime Has high acid tolerance, since it grows from pH 3 to 9.

Sucrose or glucoso agar plates: Colonies are colorless, round, very much raised, and uniformly turbid, having much the appearance of heavy starch paste. After two weeks, a buff to light brown color develops.

Mannitol agar slant: Grows very

Peptone agar slant with 0.5 per cent glucose: Limited gravish growth.

Nutrient broth: No growth.

Liquid media generally: Turbidity with some sediment.

Fixes atmospheric nitrogen readily with either glucose or sucrose as source of energy.

Aerobic

Optimum temperature: 30°C.

Distinctive characters: Tolerance of acidity, wide limits of pH tolerated, abundant slime production, large globules of fat within cells.

Source: Soils of India. Habitat: Soils

riabitat: Soli:

Appendix I: The relationship of the following species to the species placed in Azotobacter is not yet entirely clear.

### Genus Azotomonas Stapp.

(Cent. f. Bakt., II Abt., 102, 1940, 18; not Azolomonas Orla-Jensen, Cent. f. Bakt., II Abt., 24, 1909, 484.) Rod to coccus-shaped acrobic bacteria, motile by means of 1 to 3 polar fiagella. No

endospores. No fat-like reserve food granules in the cells. Form acid and gas from glucose, and other sugars and alcohols. Form indole. Chemo-heterotrophic. Many carbon compounds other than sugars used as sources of energy. Active in the fixation of atmospheric nitrogen. Lave in soil. From Gr. azous, not living, French, azote, nitrogen; Greek, monas, a unit; M. L. monad
The type species is Azothomonas insolita.

--- Ope species is increase.

Azotomonas insolita Stapp. (Abstracts of Communications, Third Internat. Congr. for Microbiol , Sect. VIII, 1939, 306, abst. in Proc. Soil Sci Soc. of America, 4, 1939, 244; Cent. f. Bakt., II Abt., 102, 1940, 1.) From Latin insolitus, unusual.

Coccoid rods: 0 6 to 1.2 by 0 6 to 1.8

microns. Motile with one to three polar flagella Gram-negative

Gelatin: No liquefaction.

Agar slant: Glistening white growth. Agar colonies: Flat, whitish, edge entire. Weakly fluorescent.

Broth: Strong turbidity. Sediment. Pellicle Milk: No change.

Potato: Growth somewhat dry, not slimy, dirty gray, spreading.

Nitrites produced from nitrates.

Fixes nitrogen.

Ammonium salts utilized.

Acid and gas from adonitol, arabinose,

dextrin, glucose, galactose, glycerine, inositol, lactose, fructose, maltose, mannitol, mannose, raffinose, rhamnose, salicin. sorbitol. starch, sucrose and xylose. Starch is hydrolyzed.

Hydrogen sulfide produced. Optimum temperature 25° to 30°C.

Minimum 7° to 9.5°C. Maximum 48°C. Good growth at 37°C. Thermal death point 60°C.

Limits of pH 3.3 to 9.5.

Aerobic.

Source: From a mixture of chopped cotton husks and rice hulls.

Habitat: Soil.

#### FAMILY IV. RHIZOBIACEAE CONN.

(Jour. Bact., \$6, 1938, 321.)

Cells without endospores, rod-shaped, sparsely fagellated (one polaror lateral flagellum, or 2 to 4 peritrichous ones); some species non-motile. Usually Gram-negative, One genus (Chromobacterium) produces a violet pigment. Grow aerobically on ordinary culture media containing glucose. Glucose and sometimes other carbohydrates are utilized, without appreciable acid formation. Saprophytes, symbionts and pathogens. The latter are usually plant pathogens forming abnormal growths on roots and stems.

#### Key to genera of family Rhizobiaceae.

 Cells capable of fiving free nitrogen when growing symbiotically on the roots of Leguminosae.

Genus I. Rhizobium, p 223.

II. Either plant pathogens which attack roots or produce hypertrophies on stems, or free-living non-chromogenic soil or water forms Do not fix nitrogen. Genus II Agrobacterium, p. 227.

III. Usually free-living soil and water forms which produce a violet chromogenesis.

Genus III. Chromobacterium, p. 231.

#### Genus I Rhizobium Frank.\*

(Phytomyza Schroeter, in Cohn, Kryptogamen-Flora von Schlesien, 5, 1886, 131; Frank, Ber. d. deut. bot. Gesellsch, 7, 1889, 389, Rhivobacterium Kirchner, Beitr z. Biol. d. Pflanzen, 7, 1895, 221; Rhizomonas Orla-Jensen, Cent. f. Bakt, II Abt, 22, 1909, 323) From Greek rhiza, root, bios, life

Rods: 0 5-0.5

in which acidi.

negative. Aerobic, heterotrophic, growing best with extracts of yeast, malt or other plant materials. Nitrates may be reduced to mitrites. Nitrates are not utilized felatin is not liquefied or is very slightly liquefied after long incubation. Optimum temperature 25°C. This group is capable of producing nodules on the roots of Leguminosca, and of fixing free introgen during this symbiosis.

The type species is Rhizobium leguminosarum Frank

## Key to the species of genus Rhizobium.

Litmus milk alkalıne.

a. Formation of serum zone in milk

- Moderate growth, slight acid reaction on yeast water agar plus mono-, diand trisaccharides.
  - c. Causes formation of root nodules on species of the genera Lathyrus, Pisum, Vicia and Lens. Bacteroids irregular with x, y, star-, and club-shaped forms; rods peritrichous when young.

1. Rhizobium leguminosarum.

cc. Causes formation of root nodules on Phaseolus vulgaris, P. multiflorus and P angustifolius. Bacteroids vacuolated rods, few branched forms, young cells peritrichous.

Rhizobium phaseoli.

on, Wis, Jan.,

- ccc. Causes formation of nodules on species of genus Trifolium. Bacteroids pear-shaped, swollen, vacuolated. Pentoses usually not fermented.
  - 3. Rhizobium trifolii.
- aa. No serum zone formed in milk.
  - b. Scant growth, alkaline reaction on yeast water agar plus most carbohydrates.
    - c. Causes formation of nodules on species of genus Lupinus and on Ornithopus sativus. Bacteroids vacuolated, rods seldom branched.
      - Rhizobium lupini.
    - cc. Causes formation of nodules on Soja max. Bacteroids long slender rods, seldom vacuolated or branched; young cells monotrichous. 5. Rhizobium ianonicum.\*
- Litmus milk acid.
  - a. Formation of serum zone in milk.
    - Moderate growth, slight acid reaction on yeast water agar plus mono-, diand trisaccharides.
      - c. Causes formation of root nodules on species of the genera Melilotus, Medicago, and Trigonella. Bacteroids club-shaped, branched, young cells peritrichous.
        - 6. Rhizobium meliloti.

Naturreiche. 2 Theil, Botanik, III Abt., Kryptogamen, Sec. 914, 1877, 1941; Schinzia leguminosarum Frank (all species), Bot. Zig., 37, 1879, 377; Phylomyza leguminosarum Schroeter (all ex-

1 Rhizobium leguminosarum Frank emend. Baldwin and Fred. (Frank, Landwirtschäftliche Jahrbücher, 19, 1890, 563; Rhizobium polymorphum Dangeard, Rhizobium fabae Dangeard, Le Botaniste, 567: 16, 1926, 192-194; Baldwin and Fred, Jour. Bact., 17, 1929, 146.) From Latin, of the legume family (Leguminosae).

Nore: The following binomials have been used for species of this genus. The names given were used by their authors to cover one or more of the species here recognized as belonging to the genus Rhizobium. Where a question mark (?) is used it indicates that the species was too poorly described to be recognizable today. Schinzu cellulicola Frank, 1877 (all species) Leunis, Synopsis der drei species), Bot. Zig., 49, 1883, 726; Bacillus fabas Beijerinck (from broad bean) sad Bacillus ornthops Beijerinck (from serradella), Bot. Zig., 48, 1890, 837; Cladochytrium tuberculorum Vuillemin (all species?), Ann. Sci. Agron. Franc. et Etrang., 5, I, 1888, 103; Bacterum radicicola Prazmowski (all species), Landw. Vers. Sta., 37, 1800, 204; Rhito-bium mutabile Schneider (several species) Ethicobium cureum Schneider (?), Ethio-

No specific name has been proposed for the organism causing the formation of nodules on plants that are members of the so-called "cowpea" group. Data showing possible inter-relationships of certain plant species of the soybean and cowpea cross-inoculation groups prompted Walker and Brown (Soil Science, 39, 1935, 221-225) to propose a consolidation of the two groups to be recognized as being inoculated by a single species, Rhizobrum japonicum. Results obtained recently by Reid and Baldwin (Proc. Soil Sci. Soc. Amer. for 1936, 1, 1937, 219) show these inter-relationships to include the luping group also.

bium frankii var. majus and var minus Schneider (?), Rhizobium nodosum Schneider (?). Rhizobium dubium Schneider (?), Bul, Torrey Bot. Club, 19, 1892, 213, Rhizobium sphaeroides Schneider (?), Ber. deut. bot Gesell., 12, 1894, 16: Bacillus tuberigenus Gonnermann and Micrococcus tuberigenus Gonnermann, Landw. Jahrb , 23, 1894, 654, 657, are thought by Fred, Baldwin and McCoy (University of Wisconsin, Studies in Science, No. 5, 1932, 140) not to be true nodule organisms and to be too poorly described to be recognizable today; Rhyzobium pasteurianum Mazé (all species), Ann. Inst. Pasteur, 13, 1899, 146; Pseudorhizobium ramosum Hartleb (?) (Chem. Zeit., 24, 1900, 887) (used for noninfective culture claimed by Stutzer (Mitt. Landw. Inst Breslau, 1, Heft 3, 1900, 63) to be genuine root nodule organism), Rhizobium radicicola Hiltner and Stormer (several species) and Rhizobium benerinches Hiltner and Störmer (from lupine, serradella and soy bean), Arb. Biol. Abt. f. Land-u Forstwirthschaft a. K. Gesundheitsamte, 3, 1903, 269; Pseudomonas radicicola Moore (all species), U. S. Dept Agr. Bur. Plant Ind., Bul. 71, 1905, 27, Rhizomonas beijerinchii Orla-Jensen and Rhizomonas radicicola Orla-Jensen (see Hiltner and Störmer), Cent. f. Bakt , II Abt , 22, 1909, 328; Bacillus or Bacterium radicicola Löhnis and Hansen (peritrichous species), Jour. Agr. Research, 20, 1921, 551, Rhizobium radicicolum Bergey et al , Manual, 1st ed., 1923, 40 (monotrichous species); Rhizobium loti Dangeard (from lotus), Rhizobium simplex Dangeard (from sainfoin), Rhizobium torulosum Dangeard (from Scotch broom), Le Botaniste, Ser. 16, 1926, 195-197. Rods · 0.5 to 0.9 by 1 2 to 3 0 microns

Motile with peritrichous flagella. Bacteroids commonly irregular with x, y, star- and club-shaped forms. Vacuolate forms predominate. Gram-negative

Growth on mannitol agar is rapid, with tendency to spread. Streak is raised, glistening, semi-translucent, white, slimy and occasionally viscous. Considerable gum is formed.

Slight acid production from glucose, galactose, mannose, lactose and maltose. Aerobic.

Optimum temperature 25°C

Source: Root nodules on Lathyrus, Pisum (pea), Vicia (vetch) and Lens (lentil).

Habitat: Widely distributed in soils where the above mentioned legumes are grown

 Rhizobium phaseoli Dangeard. (Le Botaniste, Sér. 16, 1926, 197.) From Latin, phaseolus, bean; M. L. Phaseolus, a generic name.

Rolds. Motile with peritrichous flagelds Bacteroids are usually rod-shaped, often vacuolated with few branched forms Usually smaller than in Rhizobium leguminosarum and R trifolis Gram-neartive.

Growth on mannetol agar is rapid with tendency to spread. Streak inoculation is raised, glistoning, semi-translucent, white, slimy Occasionally mucilaginous but this character is not so marked as in Rhizobium trifolix.

Very slight acid formation from glucose, galactose, mannose, sucrose and lactose

Acrobic.

Optimum temperature 25°C

Source Root nodules of Phaseolus sulgaris (kidney bean), P angustifolius (bean) and P. multiforus (scarlet runner) (Burtill and Hansen, Ill. Agr. Exp Sta. Bul 202, 1917, 137.)

Habitat Widely distributed in the soils in which beans are grown

3 Rhizobium trifolii Dangeard. (Le Botaniste, Sér. 16, 1926, 191.) From M. L. Trifolium, a generic name.

Rode: Motile with peritrichous flagella. Bacteroids from nodules are pearshaped, swollen and vacuolated. Rarely and y shapes. Gram-negative.

Growth on mannitol agar is rapid. The colonies are white becoming turbid with age. Frequently mucilaginous, Streak cultures transparent at first. Growth mucilaginous later flowing down the near slant and accumulating as a sluny mass at the bottom. Produces large amounts of gum.

Slight acid production from glucose, galactose, mannose, lactose and maltose, Acrobic

Optimum temperature 25°C.

Source: Root nodules of species of Trifolium (clover).

Habitat: Widely distributed in the soils where clover grows.

4. Rhizobium lupini (Schroeter) Eckhardt. Baldwin and Fred. (Phytomyza lupini Schroeter, in Cohn, Kryptogamen-Flora von Schlesien, 3, I, 1886, 135; Rhizobium minimum Dangeard, Le Botaniste, Sér. 16, 1926, 193; Eckhardt, Baldwin and Fred, Jour. Bact . 21, 1931, 273.) From Latin, Lupinus, lupine,

Rods: Motile with flagella I to 4, usually 2 or 3 Bacteroids are vacuolate rods. seldom if ever branched. Gram-negative. Growth on yeast water, mannitol agar

is scant to moderate with alkaline reaction.

Beef-peptone gelatin: Little growth with extremely slow liquefaction.

On galactose an alkaline reaction serves to differentiate Rhizobium luvini from all fast-growing rhizobia (R. phascoli, R. meliloti, R trifolii, and R leguminosarum). An initial alkaline reaction followed more quickly by an acid reaction on rhamnose and avlose separates R. lupini from slow-growing R. japonicum and the Rhizobium sp. from cow pea. In general Rhizobium lupini produces

slight to moderate acidity on pentose sugars and no change or alkaline reaction on hexoses, disaccharides and trisaccharides.

Litmus milk: No serum zone, no reduction, and a slight alkaline reaction.

Meager growth on potato and parsnip slants, and carrot agar.

Acrobic.

Ontimum temperature 25°C.

Source: Root nodules on Lupinus (lupine). Serradella and Ornithonus. Habitat: Widely distributed in soils in which these legumes grow.

5. Rhizobium japonicum (Kirchner) Buchanan. (Rhizobacterium japonicum Kirchner, Beiträge zur Biol, d. Pflanzen, 7, 1895, 213; Pseudomonas japonica Löhnis and Hansen, Bacterium japonicum Löhnis and Hansen, Jour, Agr. Res., 20, 1921, 551; Rhizobium sojae Dangeard, Le Botaniste, Sér. 16, 1926, 200: Buchanan, Proc. Iowa Acad. Sci., 55, 1926, 81.) From M. L., of Japan-

Rods Motile with monotrichous flagella Bacteroids of nodules are long and slender with only occasional branched and swollen forms. Gram-negative-

Growth on mannitol arms is slow and scant. The streak is slightly raised, glistening, opaque, white, butyrous, with little gum formation.

Pentose sugars give better growth than the hexases.

Little if any acid formed from carbohydrates. Acid slowly formed from xylose and arabinose.

Aerobic.

Optimum temperature 25°C.

Source: Root nodules on Soja max (sov bean).

Habitat: Widely distributed in soils where soy beans are grown.

6. Rhizobium meliloti Dangeard. (Le Botaniste, Scr. 16, 1926, 191.) From Greek, melilot, a kind of clover; M. L. Melilotus.

Rods: Motile with peritrichous fla-Bacteroids club-shaped and gella.

branched. Gram-negative. Growth on mannitol agar is fairly rapid.

The streak is raised, glistening, opaque, pearly white, butyrous. Considerable cum is formed.

Acid from glucose, galactose, mannose and sucrose.

Aerobic.

Optimum temperature 25°C.

Source: Root nodules of Melilotus (sweet clover), Medicago, and Trigonclia Habitat: Widely distributed in soils in which these legumes grow. Note: See Monograph on Root Nodule Bacteria and Leguminous Plants by E. B. Fred, I. L. Baldwin and Elrabeth McCoy, University of Wisconsin Studies in Science, Madison, No. 5, 1932, vx + 313 pp. for a more complete discussion of this group with an extensive bibliography.

## Genus II. Agrobacterium Conn.\*

(Jour. Bact., 44, 1942, 359) From Greek, agrus, a field; M.L., bactersum, a small

Small, short rods which are typically motile with 1 to 4 peritrichous flagella (if only one flagellum, lateral attachment is as common as polar). Ordinarily Gramgative. On ordinary culture media, they do not produce visible gas nor sufficient acid to be detectable by litmus. In synthetic media, enough CO<sub>2</sub> may be produced to show acid with brom thymol blue, or sometimes with brom cresol purple. Gelatin is either very slowly liquefied or not at all. Free nitrogen cannot be fived, but other norganic forms of nitrogen (nitrates or ammonum salts) can ordinarily be utilized. Optimum temperature, 25° to 30°C. Habitat Soil, or plant roots in the soil; or the stems of plants where they produce hypertrophies.

The type species is Agrobacterium tumefaciens (Smith and Townsend) Conn.

#### Key to the species of genus Agrobacterium.

- I. Plant pathogens. Produce browning of mannitol-calcium-glycerophosphate agar.

  Nitrate reduction weak or none
  - A. Nitrite produced from nitrate to a slight extent. Galls produced on plant roots.

    1. Agrobacterium tumefaciens.
  - B. Nitrite not produced from nitrate.
    - 1. Pathogenic to apples
- 2. Agrobacterium rhizogenes.
- Pathogenic to raspberries and blackberries.
   Agrobacterium rubi.
- Not pathogenic to plants. Produces browning in mannitol-calcium-glycerophos
  phate agar. Nitrate reduction vigorous, with disappearance of the nitrate
  - 4 Agrobacterium radiobacter.
  - 1. Agrobacterium tumefaciens (Smith d'Townsend) Conn. (Bacterium tume-sciens Erw. Smith and Townsend) Seigns (From Latin tumefaciens, swell-ciens Erw. Smith and Townsend) Seigns (pp. producing a tumor.)
    - Probable synonyms: Bacillus ampelopsorae Trevisan, in Sacardo, Sylloge Fungorum, 8, 1899, 983; Bacillus ampelopsorae Trovisan emend. Cavara, Staz. Sperim. Agara. Ital. Modena, 20, 1897, 483; see Elliott, Bact. Plant Pathogens, 1930, 235.

and Townsend) Conn. (Bacterium tumefactins Erw. Emith and Townsend, Science, N. S. 25, 1907, 672, Pseudomonas tumefaciens Stevens, The Fungi which Cause Plant Disease, 1913, 35, Bacillus tumefaciens Holland, Jour. Dact., 6, 1920, 220; not Bacillus tumefaciens Wilson, Lancet, 1, 1919, 675; Phythomonas tumefaciens Bergey et al., Manual, 1st cd.,

<sup>\*</sup> Prepared by Prof. H. J. Conn, New York State Experiment Station, Geneva, New York, September, 1943.

Among the synonyms listed in provious editions of the Manual has been Polymonas tumefaciens Lieske, Cent. I. Bakt., I Abt., Orig., 108, 1928, 118. This is only a partial synonym, however, as its author described it as the cause of animal and human cancer, of which he regarded crown-gall of plants as merely a phase: for the origin of this theory, see Smith and Townsend, Sci., N.S. 25, 1907, 671, and Smith, Jour. Cancer Res., 7, 1922, 1-195.

Description taken from the following: Richer, Banfield, Wright, Keitt and Sagen, Jour. Agr. Res., 41, 1939, 507; Sagen, Riker and Baldwin, Jour.Bact., 28, 1934, 571, Hendrickson, Baldwin and Riker, Jour. Bact., 28, 1934, 597.

Rods: 0.7 to 0.8 by 2 5 to 3.0 microns, occurring singly or in pairs. Capsules. Motile with 1 to 4 flagella. Gramnegative

Agar colonies: Small, white, circular, smooth, glistening, translucent, entire. Broth Slightly turbid, with thin pellicle.

Litmus milk: Slow coagulation. Litmus reduced Neutral to alkaline. Nitrites produced from nitrates to a

very slight extent.
Indole: Slight amount-

Slight acid from glucose, fructose, arabinose, galactose, mannitol and salicin.
Starch not hydrolyzed.

Optimum temperature 25° to 28°C. Facultative anserobe.

Distinctive characters: Causes a gall formation parenchymatous in character which because of its soft nature is subject to injury and decay.

Agrobacterium tumcfaciers strongly absorbs congo red and aniline bluo in contrast to little or no absorption by A. rhizogenes. A. tumcfaciens makes abundant growth on sodium selenite agar and calcium glycerophosphate medium with mannitol in contrast to no growth or a very slight trace by A. rhizogenes (Hendrickson et al., Jour. Bact., 28, 1934, 597).

Source: Isolated from galls on plants. Habitat: Causes galls on Paris daisy and cross-inoculable on over 40 families

Agrobacterium rhizogenes (Riker et al.) Coun. (Bacterium rhizogenes Riker, Banfield, Wright, Keitt and Sagen, Jour. Agr. Res., 41, 1930, 536; Phylomonas rhizogenes Riker et al., ibid, 536; Pesudomonas rhizogenes Riker et al., ibid, 536; Cenudomonas rhizogenes Riker et al., ibid, 536; Conn, Jour. Bact., 44, 1942, 359.) From Greek, rhiza, root; genes, producing.

Rods: 0.4 by 1.4 microns, occurring singly. Motile with one to 4 flagella Encapsulated. Not acid-fast. Gramnegative.

Gelatin: No liquefaction.

Agar colonies: Circular, smooth, convex, finely granular; optical characters, translucent through gray to almost white.

Agar slant: Moderate, filiform, translucent, raised, smooth, slimy.

Broth: Turbid, with heavy pellicle. Litmus milk: Acid, slow reduction. Indole not formed.

Nitrites not produced from nitrates. Acid but not gas from arabinose, xylose, rhamnose, glucose, galactose, mannose, maltose, lactose, salicin and erythritol. No acid or gas from fructes, sucrose, rafinose, melezitose, starch, dextrin, inulin, aesculin, dulcitol or mannitol.

Starch not hydrolyzed.

Optimum temperature 20° to 25°C. Aerobic.

Distinctive characters: Agrobacterium rhizogenes differs from Agrobacterium tumefaciens by stimulating root formation instead of soft parenchymatous crown galls A. rhizogenes lacks ability of A. tumefaciens to utilize simple nitrogenous compounds as KNO<sub>2</sub>. A. rhizogenes absorbs congo red and brom thymol blue slightly and aniline blue not at all Will not grow on sodium selenite agar (see A. tumefaciens for response to eame materials). Does not infect tomato.

Sources: Description made from ten cultures isolated from hairy-root of apple and other plants.

Habitat: Pathogenic on apple, etc

Agrobacterium rubi (Hildebrand)
 Starr and Weiss. (Phylomonas rubi Hildebrand, Jour. Agr. Res., 61, 1940, 694; Bacterium rubi Hildebrand, ibid., 694; Banfield, Phytopath, 20, 1930, 123; Punckard, Jour. Agr. Res., 69, 1935, 693;
 Starr and Weiss, Phytopath, 33, 1943, 316.) From Latin, rubus, blackberry bush; M. L., Rubus, a genene name.

Rods: 0.6 by 1.7 microns Singly, in pairs or short chains. Mottle with 1 to 4 flagella. Gram-negative.

Gelatin: No liquefaction

Potato-mannitol-agar slants Growth slow, moderate, filiform, white to creamywhite, with butyrous consistency later becoming leathery.

Broth: Turbid in 36 to 48 hours Milk: A slight serum-zone, pink color,

acid and curd formed.

Nitrites not produced from nitrates Ferne ammonium citrate, uric acid, oxamide, succinimide, I-asparagine, Ityrosine, I-cystine, d-glutamic acid and yeast extract can be used as a source of nitrogen (Puchard. loc. cit.).

Hydrogen sulfide not formed

Indole not formed.

Acid from glucose, d-galactose, d-mannose, d-fructose, d-xylose, d arabinose, sucrose, and maltose None from lactose (Pinchard, loc. cit).

Starch not hydrolyzed

Optimum temperature 28°C Minimum 8°C, and maximum 36°C (Pinck-

ard, loc. cit ).

Distinctive characters Differs from Agrobacterium tumefaciens in that it does not uthize nitrates, and grows much more slowly on ordinary media. Infects only members of the genus Rubus Starr and Weiss (Phytopath, 33, 1913, 317) state that this species unlike Agrobacterium tumefacerum and Agrobacterum and

rhizogenes does not utilize asparagin as a sole source of carbon and nitrogen

Source: Isolated by Banfield (loc. cit.) and by Hildebrand (loc. cit.) from rasp-berry canes, Rubus spp.

Habitat: Pathogenic on black and purple cane raspberries, and blackberries, and to a lesser extent on red raspberries.

4. Agrobacterium radiobacter (Bei-jerinek and van Delden) Conn. (Bacillus radiobacter Beijerinek and van Delden, Cent. f. Bakt., II Abt., 9, 1902, 3; Bacterium radiobacter Ednins, Cent. f. Bakt., II Abt., 14, 1905, 589; Rhizobium radiobacter Pirinm, Misasifikation der Schizomyceten, Leipzig, 1933,53; Achromobacter radiobacter Bergy et al., Manual, 4th ed., 1934, 230; Altaligenes radiobacter Bact., 44, 1913, 359.) From Latun, radius, the spoke of a wheel; Latin, bactrum, a rad.

Small rods, 0 15 to 0 75 by 0 3 to 2.3 microns, occurring singly, in pairs and under certain conditions, in star-shaped clusters. Motile with one to four flagella. Prevailingly Gram-negative, but an occasional culture is variable.

Nutrient gelatin stab · No liquefaction Agar slant: Flat, whitish slimy layer. Mannitol-calcium-glycerophosphate-

simp growth surrounded by a brown halo with an outer zone of white precipitate (Riker et al., Jour Agr. Res., 41, 1930, 524)

Broth Turbid; with heavy ring or pellicle if yeal infusion is present.

Litmus milk: Scrum zone with pellicle in one week; usually turns a chocolate brown in 2 weeks; same in plain milk, but with less browning.

Potato Raised slimy mass becoming brownish; potato may be browned.

Nitrates disappear (assimilated or reduced)

Starch not hydrolyzed.

No organic acid or visible gas from sugars; nearly all sugars, glycerol and mannitol are utilized with the production of CO<sub>2</sub>.

Optimum temperature 28°C, Minimum near 1°C, Maximum 45°C, Appolie.

Media containing KNO<sub>4</sub>, K<sub>2</sub>HPO<sub>4</sub>, and glycerol, ethyl or propyl alcohol become alkaline to phenol red. (Sigen, Riker and Baldwin, Jour Bact, 28, 1931, 571.)

Growth occurs in special alkaline media of pH 11.0 to 12.0 (Hofer, Jour Amer. Soc Agron., 27, 1935, 228)

Hydrogen sulfide produced if grown in ZoBell and Feltham's medium (Jour. Bact , 28, 1931, 169)

Distinctive characters: Browning of mannitol-calcium-glycerophosphate agar. Inability to cause plant disease or to produce nodules on roots of legumes. Complete utilization (disappearance of nitrate) in the peptone-salt medium of Riker et al. (Jour. Agr. Res., 41, 1930, 529) and failure to absorb congo red (tbtd., 528).

The species bears at least superficial resemblances to certain Rhizobium spp., but may be distinguished from them by the first two characters listed above, and the following in addition. Growth at a reaction of pill 11-12. Heavy ring or pellicle formation on veil influsion broth. His production in the mannitol-tryptone medium of ZoBell and Feltham (loc cit). Production of milky white precipitate on nitrate-glycerol-soil-extract agar.

Source: Isolated from soil

Habitat Soil, around the roots of plants, especially legumes

Nors. Palacios and Bari (Proc. Indian Acad. Sc<sub>1</sub>, 3, 1936, 362, Abs in Cent. f. Bakt, II Abt., 95, 1937, 423) have described Bacillus concomitans as a symbiont from legume nodules that has no power to fix nitrogen although it is very much like legume nodule bacteria (Rhizobium spp.). This organism resembles Agrobacterium radiobacter.

Appendix: The following species probably belong in Agrobacterium, but are not sufficiently well described to make their relationship certain.

 Agrobacterium gypsophilae (Brown) Starr and Weiss. (Bacterium gypsophilae Brown, Jour. Agr. Res., 48, 1934, 1109, Pseudomonas gypsophilae Stapp, Bot. Rev., 1, 1935, 197; Phytomonar gypsophilae Stapp, ibid., 497; Starr and Weiss, Phytopath., 35, 1913, 316.) From M. L., Gypsophila, a generic name.

Rods: 0.2 to 0.8 by 0.4 to 1.4 microns. Motile with 1 to 4 flagella. Capsules. Gram-negative.

Gram-negative.
Gelatin: Liquefaction slow, beginning after 1 month.

Beef-infusion agar colonies: Circular, Naples yellow, smooth or rough, butyrous Broth: Turbid in 24 hours.

Milk: Congulation and peptonization. Nitrites are produced from nitrates Indole not produced.

Hydrogen sulfide: A trace may be produced.

Acid but not gus from glucose, sucrose, multose, mannitol and glycerol. No acid from lactose.

Starch not hydrolyzed.

Aerobic, facultative.

Distinctive characters. Differs from Xanthomonas beticola in starch hydrolysis, II<sub>2</sub>S production, and will not cross-inoculate with this species.

Source · Isolated from several galls on Gupsophila.

Habitat: Produces galls in Gypsophila paniculata and related plants.

2. Bacterium pseudotsugae I Iansen and Smith (Hansen and R. E. Smith, Hulpardia, 10, 1937, 576; Phylomonas pseudotsugae Burkholder, in Manual, 5th ed., 1939, 209.) From M. L., Pseudotsuga a generic name.

Rods 0.5 to 1.5 by 1 9 to 3.9 microns Probably motile; type of flagellation doubtful. Gram-negative

Gelatin: Liquefied

Nutrient agar slant: Growth scanty, flat, glistening, smooth, translucent, whitish.

Broth: Growth slight No sediment Milk . No acid.

Nitrites produced from nitrates.

Hydrogen sulfide production slight. Acid but not gas from glucose, frucStarch not hydrolyzed.

Facultative serobe.

Source. Isolated from galls on Douglas fir in California.

tose, galactose and maltose. No acid or

gas from lactose, sucrose or glycerol.

Habitat . Pathogenic on Douglas fir, Pseudotsuoa taxifolia.

#### Genus III Chromobacterium Bergonzins.\*

(Ann. Societa d. Naturalisti in Modena, Ser. 2, 14, 1881, 153.) Greek, chroma, color; M. L., bacterium, a small rod

Rods, 0 4 to 0 8 by 1 0 to 5 0 microns Motile with 1 to 4 or more flagella. Gramnegative. A violet pigment is formed which is soluble in alcohol, but not in water or chloroform. Grow on ordinary culture media, usually forming acid from glucose, sometimes from maltose, not from lactose Gelatin is liquefied. Indole is not produced. Nitrate usually reduced to nitrite. Optimum temperature 20-25°C but. some grow well at 37°C Usually saprophytic soil and water bacteria.

The type species is Chromobacterium violaceum (Schroeter) Bergonzini.

## Key to the species of genus Chromobacterium.

I Motile rods. Single flagellum.

A. Acid from glucose and maltose No acid from sucrose. Nitrites produced from nitrates. No growth at 37°C

1 Chromobacterium violaceum

II. Motile rods. Flagella generally perstrichous

A. Acid from glucose. Nitrites generally not produced from nitrates Good growth at 37°C

B. Generally no acid from glucose growth at 37°C

 Chromobacterium ianthinum. Nitrites produced from nitrates No

Chromobacterium violaceum (Schroeter) Bergonzini. (Bacteridium tiolaceum Schroeter, Beitrage z Biol d Pflanzen, I, Heft 2, 1872, 126, Micrococcus riolaceus Cohn, Beitrage z Biol d. Pflanzen, 1, Heft 2, 1872, 157, Cromobacterium violaceum (sic) Bergonzini, Ann. Societa d Naturalisti in Modena, Ser. 2, 14, 1891, 153, Bacillus violaceus Schroeter, Kryptogamen-Flora von Schlesien, 3, 1886, 157, Streptococcus violaceus

Trevisan, I generi e le specie delle

3 Chromobacterium amethystinum.

Batteriacce, 1889, 31, Pseudomonas violacea Migula, Arb a. d Bakt. Inst. Karlsruhe, 1, 1894, 237; Bacterium violaceum Lehmann and Neumann, Bakt, Diag , 1 Aufl , 2, 1896, 58; see 2 Aufl., 2, 1899, 262 ) From Latin, violaceus. violet-colored

Note: Bacterium ianthinum Zopf (Die Spaltpilze, 1885, 68) has been regarded as identical with the above organism by Schroeter (Kryptogamen-Flora von Schlesien, 5, 1, 1886, 157), and by Leh-

Adapted by Prof. Robert S. Breed, New York State Experiment Station, Geneva. New York from Cruess-Callaghan and Gorman, Scientific Proc. Royal Dublin Society, 21, 1935, 213 in Jan 1938, further revision, July, 1915 by Robert S. Breed with the assistance of Capt. W C Tobie, Sn. C., Old Greenwich, Conn.

mann and Neumann (Bakt. Diag., 1 Aufl., 2, 1896, 266; also 7 Aufl., 2, 1927, 643). Lehmann and Neumann (loe. cit.) also consider Bacillus violaceus lauventicus Lustig (Diagnostik der Bakterien des Wassers, 1893, 103) as being identical with Bacterium violaceum.

Slender rods: 0.8 to 1.0 by 2.0 to 5.0 microns, occurring singly and in chains. Motile, with a single flagellum. Gramnegative.

Gelatin colonies: Circular, gray, entire margin, assuming a violet color in the center.

Gelatin stab: Infundibuliform liquefaction with violet sediment in fluid. Agar colonies: Whitish, flat, glistening.

moist, becoming violet.

Agar slant: Deep, violet, moist, shiny

spreading growth.

Broth: Slightly turbid, with violet

ring and ropy sediment
Litmus milk: Violet pellicle. Diges-

tion. Alkaline.
Potato: Limited, dark violet growth.

Löffler's blood serum : Slowly liquefied.
Indole not formed.

Nitrites produced from nitrates.

Acid from glucose and usually from maltose No acid from lactose or sucrose. Aerobic, facultative.

Optimum, temperature 25° to 30°C. No growth at 37°C Slight growth at 2° to 4°C.

Source Originally grown on slices of cooked potato exposed to air contamination, and incubated at room temperature. Habitat: Water

2. Chromobacterium ianthinum (Zopf) Holland. (Bacterium ianthinum Zopf, Die Spaltpilze, 2 Aufl., 1884, 62; Bacillus janthinus Flugge, Die Mikroorganismen, 1886, 201; Bacterdalum ianthinum Schroeter, Kryptogamen Flora von Schlesien, 5, 1, 1886, 157; Pseudomonas tanthina Migula, Syst. d. Bakt. 2, 1900, 941, Pseudomonas janthina Chester, Man. Determ. Bact., 1901, 317; Holland, Jour. Bact., 6, 1920, 222.) From Greek, tanthinus, violet-blue.

Rods: 0.5 to 0.8 by 1.5 to 5.0 micross, occurring singly. Motile with peritrichous flagella. Gram-negative.

Gelatin colonies: Circular, yellow, becoming violet.

Gelatin stab: White to violet surface growth. Infundibuliform liquefaction. Agar colonies: Creamy center, violet

margin. Agar slant: Yellowish, moist, glisten-

ing, becoming deep violet.

Broth: Turbid, with light violet pellicle.

Litmus milk: Slow coagulation with violet cream layer. Litmus decolorized from below.

Potato: Violet to violet-black, spreading growth.

Indole not formed.

Nitrites generally not produced from nitrates.

Acid from glucose. No acid from maltose, lactose and sucrose.

Aerobic, facultative.

Optimum temperature 30°C. Grows well at 37°C. No growth at 2 to 4°C.

Source: Originally grown on pieces of pig's bladder floated on badly contaminated water.

Habitat: Water and soil. This may be the species that causes a fatal septicemia in animals and man. See Chromobacterium violaceum manilae.

amethystinum 3. Chromobacterium (Chester) Holland. (Bacillus membranaceus amethystinus Eisenberg, Bakt. Diag., 1891, 421; Bacterium amethystinus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 117; Bacterium membranaceus amethystinus Chester, ibid., 138; Bacillus amethystinus Holland, Jour. Bact., 5, 1920, 217; not Bacillus amethystinus Chester, loc. cit., 262; Holland, loc. cit., 222; Bacterium membranaceum amethystinum Lehmann and Neumann, Bakt. Ding , 7 Aufl., 2, 1927, 463; Bacterium violaceum amethystinum Cruess-Callaghan and Gorman, Sci. Proc. Royal Dublin Society, 21, 1935, 219.) From Greek, bluish-violet, amethyst.

Itods: 0 5 to 0.8 by 1.0 to 1.1 microns, occurring singly. Motile with a single or occasionally with peritrichous flagella Gram-negative.

Gelatin colonies Thun, bluish, becoming violet, crumpled

Gelatin atab: Heavy, violet black pelliele. Liquefied. Agar colonies: Deep violet, surface

FILTOSC.

Agar slant: Thick, moret, yellowishwhite, becoming violet with metallic luster.

Broth: Pellicle with violet rediment, fluid becoming violet

Litmus milk: Violet pellicle Dicestion turning alkaline

Potato: Deep violet, rugose spreading growth.

Indole not formed

Nitrites produced from nitrates Usually no acid from glucose, maltose and sucrose. No acid from lactore

Aerobic, facultative.

30°C Optimum temperature growth at 37°C. Good growth in 7 days at 2 to 4°C.

Original source. Yound once by Jolles in spring water from Spalato

Habitat : Water.

Appendix: The following organisms have been assigned to this genus or are believed to belong here Additional comparative studies are badly needed Besjerinck.

Bacillus eyaneo-fuscus (Beijerinck, Bot Ztung , 49, 1891, 791, Bacterium eyanofuscus Chester, Ann Rept Del. Col. Agr Exp Sta , 9, 1897, 116 and 132) From black glue, blue Edam cheese, nater and soil.

Bacillus lacmus Schroeter. (Schroeter in Cohn, Kryptogamen-Flora von Schlesien, 3, 1, 1889, 158 ) In greenhouse on fresh paint

Bacillus Itlacinus Macé (Tratté Pratique Bact., 6. &d , 2, 1913, 416 ) From nater.

Bacillus membranaceus amethystinus mobilis Germano. (Germano, Cent I Bakt., 12, 1892, 516; Bucillus amethystinus mobilis Kruse, in Plügge, Die Mikroorganismen, 3 Aufi , 2, 1896, 313; Bacterium amellystinus mobilis Chester, Ann. Rept Del Col Agr Exp Sta , 9, 1597, 117; Bucterium membrangeeus mobiles Chester, and, 138) Pseudo manas amethystina Migula, Syst Bakt , 2, 1900, 911; Bacillus amethystinus Chester, Man. Determ Bact , 1901, 262 ) From dust.

Bacillus paconinus Forster. (Forster, in van der Sleen, Sur l'examen bactériologique qualitatif de l'eau. Arch Teyler, Ser 2, Tome 4, 3 partie, 1891, No. 59, Haarlem, Heritiere Loosjes, Also see These, Nancy, 1931, 16.) Causes blue discoloration of L'dam cheese. Bacillus polychromogenes Chamot and (Bacille polychrome, Thiry, Compt rend See Biol , Paris, 49, 1896, vo, Chamot and Thury, Bot Gaz., 30, 1900, 378) From well water at Nancy Probably a Pseudomonas (Tobic, perean il communication)

Bacellus tiolactus Frankland and Frankland (Frankland and Frankland, Ztschr. f. Hyg., 6, 1888, 391, Pseudomonas pseudoranthina Migula, Syst d. Bakt., 2, 1900, 912.) Isolated from tap water. Said to produce spores.

Bacillus violaceus laurentius Jordan (Jordan, Mass. State Bd Health Rept., 1890. 838. Bacterium violaceus laurentius Chester, Ann Rept Del. Col Agr. Exp. Sta., 9, 1897, 117, Pseudomonas laurentia Migula, Syst d. Bakt, 2, 1900, 911; Bucillus riolaceus Chester, Man Determ Bact , 1901, 262, Chromohacterium violaceum laurentium Ford. Textb Bact , 1927, 470 ) Isolated from sewage effluent

Racillus violaceus luteliensis Krusc. (Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 311, Bacillus luteliensis Chester, Man. Determ. Bact., 1901, 306; Chromobacterium violaceum lutetiense Ford, Textb. Bact., 1927, 470.) From water.

Bacıllus violaceus sartoryi Waeldele. (Thèse, Pharm Strasbourg, 1938, 55.) From dental pus. Said to form spores.

Bacterium cristallino violaceum Cholkevitch. (Cholkevitch, 1922, quoted from Godfrin, Contribution a l'étude des bactéries bleues et violettes. Thése, Nancy, 1934, 93) From peat.

Chromobacterium bamptonii Bergey et al. (Bacilus membranaceus amethystinus II, Bampton, Cent. f. Bakt., I Abt., Orig., 71, 1913, 137, Bergey et al., Manual, 1st ed., 1923, 119; Chromobacterium membranaceum amethystinum II Ford, Textb. Bact., 1927, 473) From water.

Chromobacterum coeruleum (Voges) Bergey et al. (Bacillus coeruleus Voges, Cent. f Bakt., 14, 1893, 303; Bacterium coeruleus Chester, Ann. Rept Del Col Agr. Exp Sta. 9, 1897, 117; Pseudomonas coerulea Migula, Syst. d. Bakt., 2, 1900, 945; Bergey et al., Manual, 1st ed., 1923, 120.) From water.

Chromobacterium cohaerens Grimes. (Sci. Proc. Royal Dublin Society, 19, 1930, 381) From well water.

Chromobacterium hibernicum Grimes. (Sci. Proc Royal Dublin Society, 19, 1930, 381.) From well water.

Chromobacterium Iiridum (Voges) Holland (Plagge and Proskauer, Zeitsch. f Hyg., 2, 1887, 463; Bacillus Iiridus Voges, Cent f. Bakt, 14, 1893, 303; relationship to Bacillus Iiridus Zimmermann uncertain. Die Bakt. unserer Trink- und Nutzwässer, Chemnitz, 2, 1894, 18; Bacillus violaceus berolinensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufi, 2, 1896, 311, Bacterium Iiridus Chester, Ann Rept Del. Col. Agr. Exp Sta., 9, 1897, 117; Bacillus berolinensis Chester, Man Determ Bact., 1901, 305; Holland, Jour. Bact., 5, 1920, 215) From water

Chromobacterium maris-mortui Elazari-Volcam (Studies on the Microforce of the Dead Sea, Thesis, Hebrew Univ, Jerusalem, 1940, vii and 76) From the Dead Sea.

Chromobacterium membranaceum Bergoy et al. (Bacillus membranaceus amethystinus I, Bampton, Cent f. Bakt., I Abt., Orig., 71, 1913, 135; Bergey et al , Manual, 1st ed., 1923, 119; Chromobacterium membranaceum amethystinum I Ford, Textb. Bact., 1927, 472.) From water.

Chromobacterium membranaceum amethystinum III Ford. (Ford, Textb Bact., 1927, 474; Bacillus membranaceus amethystinus III Bampton, Cent. f. Bakt., IAbt., Orig., 71, 1913, 138.) From water.

Chromobacterium membranaceum amethystinum IV Ford. (Ford. Art) Bact., 1927, 474; Bacillus membranaceus amethystinus IV Bampton, Cent. f. Bakt., I Abt., Orig., 71, 1913, 138.) From water.

Chromobacterium smithii (Chester) Bergey et al. (Bacillus coeruleus Smith, Medical News, 2, 1887, 758; Bacterium coeruleus Chester, Ann. Rept. Del. Col. Agr Eyp. Sta., 9, 1897, 118; Peeudomonas smithii Chester, Man. Determ. Bact., 1901, 318; Chromobacterium coeruleum Ford, Tevth Bact., 1927, 475; not Chromobacterium coeruleum Bergey et al., 1904, 121) From water.

totd, 121) From water.
Chromobacterium riolaceum manilae Wodley, U. S. Dept. Int., Bur. Govt. Labs. Bull. 15, 1904 and Bull. Johns Hopkins Hosp., 16, 1905, 89; Ford, Tevtb. Bact. 1927, 471.) Isolated from fatal septicemias in water buffalo (Woolley) and man (Schattenberg and Harris, Jour. Bact, 44, 1912, 269). More likely to be a variety of Chromobacterium ianthinum which grows at 37°C. than of C. violaceum which does not grow at 37°C.

Chromobacterium viscofueatum (Harrison and Barlow) Bergey et al. (Bacterum viscofueatum and Baculus viscofueatus Harrison and Barlow, Cent. f. Bakt., If Abt., 16, 1905, 517; Trans. Royal Soc. Canada, 2nd Ser., 11, 1903; Bergey et al., Manual, 1st ed., 1923, 119) From oily butter Probably a non-motile Pseudomonas (Tobie, personal communication). Chromobacterium viscosum Grimes (Cent. f. Bakt., III Abt., 78, 1927, 367.)

From butter.

Pseudomonas pseudoviolacea Miguls.
(Syst. d. Bakt., 2, 1900, 943.) From

river water.

#### FAMILY V. MICROCOCCACEAE PRIBRAM.\*

#### (Jour. Bact., 18, 1929, 385)

Cells without endospores except in Sporosarcina. Cells in their free condition spherical, during division somewhat elliptical Division in two or three planes. If the cells remain in contact after division, they are frequently flattened in the plane of last division. They occur singly, in pairs, tetrads, packets or irregular masses. Motility rare. Generally foram-positive. Many species form a yellow, orange, pink or red pigment. Most species are preferably aerobic, producing abundant growth on ordinary culture media, but capable of slight anaerobic growth. A few species are strictly nanerobic. Metabolism heterotrophic. Carbohydrates are frequently fermented to acid. Gelatin is often liquefied. Facultative parasites and saprophytes. Frequently heven the skin, in skin glands or skin gland scretchings of Vertebrata.

#### Key to the genera of family Micrococcaceae.

I. Cells occur in plates, groups or in irregular packets and masses, nover in chains. Pigment, when present, is yellow, orange or red. Gram-positive to Gram-negative.

#### Genus I. Micrococcus, p 235

- II. On the animal body and in special media cells occur as tetrads. In ordinary media cells may occur in pairs and irregular masses. White to pale yellow. Genus II. Gaffka, p. 283
- III. Cells occur in regular packets Vellow or orange pigment usually formed Genus III. Sarcina, p. 285

#### Genus I Micrococcus Cohn \*

(Cohn, Beitrage z Biol d Pflanzen, 1, Heft 2, 1872, 153, Microsphaera Cohn, Arch f. path Anat , 55, 1872, 237, not Microsphaera Léveillé, Ann Sci Nat Bot . Sér. 3, 16, 1851, 381; Ascococcus Cohn, Beitrage z Biol d Pflanzen, 1, Heft 3, 1875. 154; Pediococcus Balcke, Wchnschr f Brauerei, 1, 1884, 183, Merista Van Tieghem. Traité de Botanique, Paris, 1884, 1114, Staphylococcus Rosenbach, Mikroorganismen bei den Wundinsektions-krankheiten des Menschen, 1884, 27, Monococcus Miller, Deutsch. med Wehnschr , 12, 1886, No 8, 117; Botryomyccs Bollinger, Deutsch Zischr. f. Tiermed , 13, 1887, 77, Urococcus Miquel, Ann Microg , 1, 1888, 518; Galactococcus Guillebeau, Jahrb d Schweiz, 4, 1890, 32, Rhodococcus Zopf, Ber d deutsch Bot. Gesellsch., Berlin, 9, 1891, 28, Pyococcus Ludwig, Lehrb d niederen Kryptog., 1892, 27; Planococcus Migula, Arb Bakt Inst Karlsruhe, 1, 1891, 236, Carphococcus Hohl, Cent. f. Bakt , II Abt , 9, 1902, 335, Albococcus Winslow and Rogers, Jour Int. Dis., 3, 1906, 541, Aurococcus Winslow and Rogers, ibid, 540; Pedioplana Wolff. Cent. f Bakt, H Abt, 18, 1907, 9, Melococcus Nedrigailov, Charkov Med Zurnal, 4. 1907, 301; Solidococcus, Liquidococcus, Indolococcus and Peptonococcus Orla-Jensen, Cent. f Bakt., II Abt , 22, 1909, 332, Planomerista Vuillemin, Ann. Mycol . 11, 1913, 525, Tetracoccus Orla-Jensen (in part), The Lactic Acid Bacteria, 1919, 76) From Greek micrus, small, coccus, a grain, M L , a sphere

Cells in plates or irregular masses (never in long chains or packets) Gram-positive to Gram-negative Growth on agar usually abundant, some species form no

<sup>\*</sup> The genera Micrococcus and Staphylococcus have been combined and completely revised by Prof. G. J. Hucker, New York State Experiment Station, Geneva, New York, March, 1913 so far as the aerobic species are concerned. Dr. Ivan C. Hall, Presbyterna Hospital, New York City, revised the anaerobic section, January, 1914.

pigment but others form yellow or less commonly orange, or red pigment. Glucose broth slightly acid, lactose broth generally neutral. Gelatin frequently liquefied. but not rapidly. Facultative parasites and saprophytes.

The type species is Micrococcus luteus (Schroeter) Cohn

#### Key to the species of genus Micrococcus.

- 1. Aerobic to facultative anaerobic species.
  - No pink or red pigment on agar media.
    - A. Nitrites not produced from nitrates.
      - 1. Utilize NH4H2PO4 as sole source of nitrogen.\*
        - a. Yellow pigment on agar media. Not acido-proteolytic.
          - 1. Micrococcus luteus.
        - aa. No pigment produced. Not acido-proteolytic.
          - b. Utilizes urea as a sole source of nitrogen.\*\* 2. Micrococcus ureae.
          - bb. Does not utilize urea.
        - 3. Micrococcus freudenreichii.
        - aaa. Acido-proteolytic in litmus milk.
        - 8. Micrococcus caseolyticus 2. Do not utilize NH4H2PO4 as sole source of nitrogen.
          - a. Yellow pigment produced.

            - 4. Micrococcus flavus. aa No pigment produced.

    - B. Nitrites produced from nitrates.
      - Utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as sole source of nitrogen.
        - a. Yellow pigment on agar media. Not acido-proteolytic. Gelatin liquefied.
          - 6. Micrococcus conglomeratus.
          - bb Gelatin not liquefied.
        - 7. Micrococcus varians. aa Usually not chromogenic. Actively acido-proteolytic in litmus milk.
        - 8. Micrococcus caseolyticus. 2 Do not utilize NH, H, PO, as sole source of nitrogen.

          - a Gelatin liquefied Ferment mannitol. Abundant orange growth on agar media.
            - 9a. Micrococcus pyogenes var. aureus.
            - bb. Abundant white growth on agar media.
            - 9b. Micrococcus pyogenes var. albus bbb. Yellow growth on agar media.
              - 10. Micrococcus citreus.
          - an Gelatin not liquefied or very slowly liquefied.
            - b. Abundant orange to white growth on agar media Ferments mannitol.
              - 11. Micrococcus aurantiacus.

5. Micrococcus candidus.

bb. Scant white translucent growth on agar media. Does not ferment mannital.

12. Micrococcus epidermidis.

\*\* Substitute 0.1 per cent urea for the ammonium phosphate in the above medium.

<sup>\*</sup> That is, will grow and produce acid (sometimes slowly) on slants containing I.5 per cent washed agar, 0.1 per cent ammonium phosphate, 1.0 per cent glucose. 0.02 per cent potassium chloride, 0.02 per cent magnesium sulfate. Add brom-cresolpurple as an indicator (Hucker, N. Y. State Exper. Sta., Tech. Bul. 100, 1921, 25; Tech. Bul. 101, 1921, 36-40); Manual Pure Culture Study of Bacteria. Soc Amer. Bact., Geneva, N. Y., Leaflet II, 9th ed., 1944, 14.)

- Pink or red pigment on agar media.
  - A. Gelatin liquefied, slowly. Produces rose-colored pigment.
    - 13. Micrococcus roseus.
  - B. Gelatin not liquefied.
    - Non-motile.
      - a. Produces cinnabar-colored pigment on gelatin.
        - 14. Micrococcus cinnabareus.
      - as Produces light, flesh-colored pigment on agar slant. Ferments glycerol and mannitol.
        - 15. Micrococcus rubens.
      - aaa. Produces brick-colored pigment on agar slant. Does not ferment glycerol and mannitol
    - 16. Micrococcus rhodochrous.
      2. Motile. Produces red pigment.
- 17. Micrococcus agilis.
- 2. Anaerobic species.
  - I. Forms gas from nitrogenous media.
    - A. Acid from glucose.
- Micrococcus aerogenes
- B. No acid from glucose
  - No blackening of colonies in deep agar.
     Micrococcus asaccharolyticus.
- 2 Hydrogen sulfide formed Deep agar colonies become black.
- 20 Micrococcus niger
- II. No gas formed from nitrogenous media
  - A. Acid from glucose.
    - 1 Acid from lactose
    - 2 No acid from lactose
- 21. Micrococcus grigoroffi.
- 22. Micrococcus anaerobius.
- 1. Micrococcus luteus (Schroeter) Cohn. (Bacteridium luteum Schroeter, Beitr. z Biol. d. Pflan, 1, Heft 2, 1872, 119; Cohn, ibid., 153) From Latin,
- luceus golden-yellow.

  Spheres: 1.0 to 1.2 microns, occurring in pairs and fours. Non-motile. Gram-
- in pairs and fours. Non-motile. Grampositive, Gelatin colonies: Yellowish-white to
- yellow, raised, with undulate margin. Gelatin stab. No liquefaction.
- Agar colonies: Small, yellowish, glistening, raised.
- Agar slant: Citron-yellow, smooth. Broth: Clear, with yellowish sediment.
- Litmus milk: Usually slightly acid, not congulated.
- Potato: Thin, glistening, citron-yellow growth.
  - Indole not formed. Nitrites not produced from nitrates.

- Acid from glucose, sucrose and man-, nitol No acid from lactose. Starch not hydrolyzed.
  - Ammonia produced from peptone.
  - Utilizes NH<sub>4</sub>H<sub>2</sub> PO<sub>4</sub> as a source of
- Utilizes Nil<sub>4</sub>H<sub>2</sub> PO<sub>4</sub> as a sour nitrogen.
  - Saprophytic.
    Aerobic.
- Optimum temperature 25°C.
- Source: Isolated by Schroeter from
- dust contaminations on cooked potato. Habitat: Found in skim milk and dairy
- products, and on dust particles
- Micrococcus ureae Cohn. (Cohn, Beitr. z. Biol. d. Pflanzen, t, Heft 2, 1872, 1833, not Micrococcus ureae l'lugge, Die Mikroorganismen, 2 Aufl., 1886, 109; Merista ureae Prazmowski, Biol. Cent. 8, 1888, 301; Streptococcus ureae

Trevisan, I generi e le specie delle Bat-

teriacce, Milan, 1889, 31; Urococcus ureae Beijerinck, Cent. f. Bakt., IT Aht... 7. 1901. 52: Albococcus ureae Kligler. Jour. Infect. Dis 12, 1913, 442; Staphylococcus ureae Holland, Jour. Bact., 5, 1920, 225.) From Greek, urum, urine: M. L., urea. urea.

See Micrococcus liquefaciens Migula in the appendix for references to the gelatin-liquefying form of the species.

Spheres: 0.8 to 1.0 micron, occurring singly, in pairs and in clumps. Never in chains. Non-motile, Gram-variable,

Gelatin colonies. Small, white, translucent, slimy, becoming fissured.

Gelatin stab: Slight, white growth. Very slow or no liquefaction.

Agar colonies: White, slightly raised. Agar slant: Grayish-white, raised, glistening, butyrous.

Broth: Turbid, with viscid sediment. Litmus milk: Slightly alkaline: litmus slowly reduced.

Milk: Acid

Potato: Slight, gravish to pale olive growth.

Indole not formed.

Nitrates not produced from nitrates. Urea fermented to ammonium carbonate.

Acid produced from glucose, lactose, sucrose and mannitol.

Starch not hydrolyzed.

Ammonium salts are utilized Ammonia produced from peptone.

Saprophytic. Aerobic.

Optimum temperature 25°C.

Source : Isolated from fermenting urine. Habitat Found in stale urine and in soil containing urine.

3. Micrococcus freudenreichii Guillebeau. (Landwirtsch. Jahrb d. Schweiz. 5, 1891, 135 ) Named for E. v. Freudenreich, Swiss bacteriologist.

Synonyms: Micrococcus acidi lactis Krueger, Cent. f. Bakt , 7, 1890, 464 (Micrococcus acidi lactis liquefaciens Eisenberg, Bakt. Diag , 3 Aufl., 1891, 409, Micrococcus acidi lactici liquefaciens

Sternberg, Man. of Bact., 1893, 601: Micrococcus acidilactis Migula, Syst. d. Bakt., 2, 1900, 112: Micrococcus acidifcans Migula, abid.); Macrococcus lactis viscosus Sternberg, Man. of Bact., 1893. 601: Micrococcus amarifaciens Migula. Syst. d. Bakt., 2, 1900, 100; Coccus lactis viscosi Gruber, Cent. f. Bakt., II Abt., 9, 1902, 790 (Micrococcus lactis viscosi Löhnis, Cent. f. Bakt., II Abt., 18, 1907, 144); Micrococcus lactis albidus Conn. Esten and Stocking, Storrs Agr. Exp. Sta. 18th Ann. Rept., 1906, 91,

Spheres: 2.0 microns in diameter, occuring singly and in clumps, rarely in short chains. Non-motile. Gram-posi-

Milk gelatin colonies: Small, white, opaque.

Milk gelatin stab: Infundibuliform liquefaction.

Agar colonies: White, slimy,

Agar streak: White, smooth.

Broth: Turbid, with white sediment. Litmus milk: Acid; coagulated; peptonized.

Potato: Moderate white to yellow streak.

Indole not formed.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Ammonia produced from peptone.

Does not utilize urea as a source of nitrogen.

Acid from glucose, lactose and sucrose Some strains form acid from mannitol; others from glycerol.

Saprophytic.

Aerobic.

Optimum temperature 20°C.

Habitat: Milk and dairy utensils.

4. Micrococcus flavus Trevisan. (Micrococcus flavus liquefaciens Flugge, Die Mikroorganismen, 2 Aufl, 1886, 174; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 34; Micrococcus flavus-liquefaciens Chester, Man. Determ. Bact , 1901, 99.) From Latin, flavus, yellow.

Spheres: 0.8 to 0.9 micron, occurring

singly, in clumps, and occasionally in fours. Occasionally cultures are found that are motile with a single flagellum. Otherwise non-motile. Gram-variable.

Gelatin colonies: Small, circular, vellowish to yellowish-brown, somewhat serrate margin, granulated, sharply conbarret

Gelatin stab : Yellow, wrinkled surface growth with slow, crateriform lique-Inction.

Agar colonies; Small, pale vellowish,

homogeneous, entire. Agar slant; Canary-vellow, somewhat

dry, wrinkled, raised, entire. Broth: Turbid with yellowish ring and

rediment.

Litmus milk: Slightly acid, soft congulum formed, with slight reduction; slowly pentonized.

Potato: Slight, ranary-yellow growth Indole is not formed.

Nitrites not produced from nitrates Starch not hydrolyzed.

Acid is generally formed from glucose and lactore. Sucrose, glycerol and mannitol generally not fermented

Ammonium salts are utilized

Ammonia produced from peptone Non-pathogenic.

Acrobic.

Optimum temperature 25°C. Source Original source not given

Habitat: Found in skin gland seemtions, milk, dairy products, and dury utensile.

Colan 5. Micrococcus candidus (Cohn, Heitr, z. Bod. d. Pflanren, I. Helt 2, 1872, 100; Staphylococcus can is fur Holland, Jour, Hart . 5, 1939, 221 ; From Inter can't fue at ining whate

Fplores: 0.5 to 0.7 micron, occurring singly. Non-motile. Gram positive

Gristia micrica Wiste, granular, with irregular or entire margin

Gelatin wish White entlace growth Filiform, No Bourfacture

April religies, Panetiform, white, www.th, entire, indexent.

Agar slant; Smooth, white, glistening, iridescent.

Broth . Turbid, with pellicle.

Litmus milk: Shehtly acid: not coorse lated.

Potato: Thick. porcelam white. glistening.

Indole not produced.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Ammonia produced from penione.

Ammonium salts not utilized. Acid from glucose, sucrose, lactose

and electrol.

Non-rathocenic.

Aerobic. Ontimum temperature 25°C.

Source. Originally appeared as white colonies on cooked potato exposed to dust contaminations.

Habitat: Found in skin secretions. milk and darry products.

6 Micrococcus conglomeratus Migula. (Citronengelber Diploroccus, Bumm. Der Miktoorganismen der gonorrhoisel, en Schleimhauterkrankurgen, I Aufl., 1885. 17. Hierococcus citreus conglomeratus Plugge, Die Mikmorennismen, 2 Aufl. 1886, 182. Diplococous estreus conglomeratvs Bumm, ibid , 2 Auft , 187 , Neuterra estrea Trevisan. I generi e le specie delle Batteriacce, Mdan, 1889, 32. Merumapedia citrois conglomeratus Ilyan, Ann. N. Y. Acad. Sci., E. 1995, 352, Migula, Svet d Bakt , 2, 1990, 116, not Microeverys enrolameral is West rollinging 147. see Trevision, for cit, 33, Microoverus estress Wireless and Waneless, Sectobation Relational ups of the Corraciae, 190, 215 ) I'man latin, a neleg crates, miled trecties, exempled

Splant 05 to 12 rapper, occurre entely, in tone, in fore, and in large clarge Nea mobile Gram sandile. Gefrin er fmies Small, eireufer, vel-

I'm with to I are trace to Gelaun state Slow eratent en Louis farting.

Agar colonies: Luxuriant, moist, sulfur yellow. ' Agar slant: Light yellow, plumose,

slightly rugose, somewhat dull, raised center and transparent margin. Broth: Turbid, with light orange ring

and sediment.

Milk: Generally acid but not suffi-

cient to curdle.

Potato: No growth.

Indole not formed.

Nitrites produced from nitrates.

Blood not hemolyzed. Starch not hydrolyzed.

Acid from glucose and lactose generally, sometimes from sucrose. Mannitol and glycerol generally not fermented.

Ammonia produced from persons.

Utilizes NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen.

Resistant to drying and heat.

Non-pathogenic.

Aerobic.

Optimum temperature 25°C.

Source: Found in gonorrhoeal pus and dust.

Habitat: Infections, milk, dairy products, dairy utensils, water, common.

7. Micrococus varians Migula. (Merismopedia flava varians Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 346; Migula, Syst. d. Bakt., 2, 1900, 135; Merismopedia flava-varians Chester, Man. Determ. Bact., 1901, 103; Micrococcus lactis varians Conn, Esten and Stocking, Storrs Agr. Exp. Sta Rept. for 1906, 121.) From Latin, varians varying.

Spheres: 0 8 to 1.0 micron, occurring singly, in pairs and in fours. Occasionally cultures are found that are motile with a single flagellum. Otherwise nonmotile. Gram-variable.

Gelatin colonies: Small, circular, whitish to yellow, capitate, moruloid.

Gelatin stab . Scant growth. No liquefaction.

Agar colonies Small, yellow, raised, glistening.

Agar slant: Plumose, yellow, variegated. Broth: Turbid, with yellow, granular

Litmus milk: Acid; coagulated on boilg.

Potato: Raised, dry, bright-yellow, glistening.

Indole not formed.

sediment.

Nitrites produced from nitrates.
Acid from glucose, lactose, sucrose,

raffinose and frequently from glycerol and mannitol. No acid from salicin or inulin.

Starch not hydrolyzed.

Ammonia produced from peptone. Utilizes NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen.

Sanronhytic.

Aerobic.

Optimum temperature 25°C.

Source: Original strains found in a contaminated jar of sterilized milk.

Habitat: Has been found in body secretions, dairy products, dairy utensils, dust and water, including sea water.

8. Micrococcus caseolyticus Evans. (Evans, Jour. Inf. Dis., 18, 1016, 455; Micrococcus casei Hucker, N. Y. Agr. Evp. Sta. Tech. Bull. 102, 1924, 17; Probably Micrococcus casei Holland, Jour. Bact., 5, 1920, 223.)

Identical in part with Micrococcus casti acidoproteolyticus I and II Gorini, Rev. Gén. du Lait, 8, 1910, 337, Tetracoccus liquefaciens Orla-Jensen, The Lactie Acid Bacteria, 1910, 80 (Micrococcus casti liquefaciens Orla-Jensen, Doktordisputats, 1904; Tetracoccus cassı liquefaciens Orla-Jensen, The Lactic Acid Bacteria, 1919, 80; Micrococcus liquefaciens Holland, Jour. Bact., 5, 1920, 224. Also see re-rences under Streptococcus liquefaciens.) From Latin, caseus, cheese, casein; and Greck, lyticus, able to dissolve; M. L., dissolving, digesting.

Spheres, variable in size, occurring in clumps. Non-motile. Gram-positive.

Gelatin stab: Liquefaction generally

begins after first day and continues rapidly.

Agar colonies: Yellow to orange (Evans, loc cit.), pearly white (Hucker, loc. cit ).

Agar stroke 'Yellow to orange (Evans, loc. cit.), pearly white (Hucker, loc cit ), luvuriant growth.

Broth Generally grows with smooth turbidity although certain strains give heavy precipitate with clear supernatant fluid.

Litmus milk: Acid, peptomzed Whey generally clear. Potato: Scanty white growth Certain

strains may show yellow pigment
Indole not formed.

Nitrites usually produced from ni-

trates.
Acid from glucose, lactose, maltose,

mannitol and glycerol No action on raffinose Forms dextrorotary lactic acid (Orla-

Jensen, 1919, loc. cit).

Asparagin and urea decomposed by

some strains
Utilizes NH<sub>4</sub>H<sub>1</sub>PO<sub>4</sub> as a source of nitro-

gen.

Optimum temperature 22°C. Aerobic.

Saprophytic.

Source: Eight cultures from bovine

udder.

Habitat: Milk and dairy products, especially cheese, dairy utensils

9a. Micrococcus pyogenes var aureus (Rosenbach) Zopf (Staphylococcus pyogenes aureus Rosenbach, Mikroorganismen bei den Wundinfectionskrankheiten des Menschen, Wiesbaden, 1881, 19. Staphylococcus aureus Rosenbach, tud. 27. Micrococcus pyogenes var aureus Zopf, Die Spatipilize, 3. Auf, 1885, 56. Micrococcus aureus Zopf, tud. 675. Micrococcus aureus Zopf, tud. 675. Micrococcus aureus Winslow and Rogers, Jour Int Dis. 5, 1906, 551, Micrococcus aureus Winslow and Rogers, Jour Int Dis. 5, 1906, 551, Micrococcus aureus Winslow and Rogers, Jour Int Dis. 5, 1906, 551, Micrococcus facts saraans Conn, Taten and Stocking, Storrs Agr. Exp Sta Rept for 1906.

121; Staphylococcus pyogenes Andrewes and Gordon, Rept (35th) Med Officer Local Govt Board, London, 1907, 549; (Tetracoccus) Micrococcus pyogenes aureus Orla-densen, The Lactic Acid Bacteria, 1919, 81, Staphylococcus pyogenes-aureus Holland, Jour. Bact, 5, 1920, 225 From Greek, pyon, pus; M L, genes, producing From Latin, aureus, colden

Spheres 0.8 to 1.0 micron, occurring singly, in pairs, in short chains, and in irregular clumps Non-motile Grampositive.

Gelatin stab. Saccate liquefaction with yellowish pellicle and yellow to orange

yenowish pentere and yenow to brange sediment.

Agar colonies: Circular, smooth, yellowish to orange, glistening, butyrous,

entire. Agar slant: Abundant, opaque, smooth,

flat, moist, yellowish to orange.

Broth Turbid with yellowish ring and

sediment, becoming clear.

Latmus milk Acid, coagulated.

Litmus milk Acid, coagulated.

Potato: Abundant, orange, glistening. Indole not formed

Nitrites produced from nitrates.

Acid from glucose, lactose, sucrose, mannitol and glycerol, but not from reflinese, salicin or inulin.

Forms inactive or levorotary lactic acid (Orla-Jensen, loc. cit ).

Slight H2S formation

Starch not hydrolyzed.

Does not utilize NH4H2PO4, as a source of nitrogen

Ammonia produced from pentone

Pathogeme. Individual strains vary in their ability to produce hemolysin, coagulase and other metabolic products. Certun strains, under favorable conditions, produce not only evotouss (hematovin, dermatovin, lethal toxin, etc.) but also a potent enterotovin which is a significant cause of food posoning (Dolman and Wilson, Jour Immunology, 55, 1938, 130).

Acrobic, facultative

Optimum temperature 37°C.

Source: Isolated from pus in wounds

Habitat: Skin and mucous membranes. The cause of boils, abscesses, furuncles suppuration in wounds, etc.

9b. Micrococcus pyogenes var. albus (Rosenbach) Schroeter. (Stanhulococcus puggenes albus Rosenbach, Mikroorganismen bei den Wundinfektionskrankheiten des Menschen, Wiesbaden, 1884, 2; Staphplococcus albus Rosenbach, ibid., 27: Micrococcus puogenes var. albus Schroeter, in Cohn, Kryptog. Flora v. Schlesien. S. 1. 1886, 147; Micrococcus muogenes Migula, Syst. d. Bakt , 2, 1900, 87: Albococcus puogenes Winslow and Rogers, Jour Inf Dis , 3, 1906, 544; Micrococcus albus Buchanan, Vetermary Bacteriology 1911, 196; (Tetracoccus) Microccocus pyogenes albus Orla-Jensen, The Lactic Acid Bacteria, 1919, 81, Staphylococcus pyogenes-albus Holland, Jour. Bact., 5, 1920, 225.) From Latin, albus, white.

Spheres: 0.6 to 0.8 micron, occurring singly, in pairs and in irregular groups.

Non-motile Gram-positive.

Gelatin stab: Saccate liquefaction with heavy white sediment.

Agar colonies: Circular, white, smooth, glistening, entire.

Ten per cent evaporated milk agar. Growth at 20°C frequently orange (Chapman, Jour. Bact, 45, 1943, 405) Agar slant: Abundant, white, smooth,

glistening.

Broth: Turbid, with delicate pellicle and white sediment.

Litmus milk: Acid; coagulated. Little or no visible peptonization.

Potato: Thick, smooth, white, glistening.

Indole not formed.

Nitrites produced from nitrates Hydrogen sulfide is formed.

Acid formed from glucose, lactose, sucrose, glycerol and mannitol, but not from raffinose, salicin and inulin

Forms inactive or levorotary lactic acid (Orla-Jensen, loc. cit.).

Starch not hydrolyzed.

Ammonia produced from peptone.

Does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen.

Pathogenic. Production of toxins, coagulase and hemolysin as in Micrococcus aureus.

Aerobic, facultative.

Optimum temperature 37°C.

Source: Originally isolated from pur. Habitat: Skin and mucous membranes Occurs in wounds, boils, abscesses, etc.

10. Micrococcus citreus Migula. (Staphylococcus pyogenes citreus Passet, Actiologie der eiterigen phlegmone des Menschen, Berlin, 1885, 9; Micrococcu pyogenes citreus Schrooter, in Colan, Kryptog. Flora v. Schlesien, 3, 1, 1886, 147; Migula, Syst. d. Bakt., 2, 1900, 147; Staphylococcus citreus Bergey et al, Manual, 1st ed., 1923, 55.) From Lata, citreus, of or relating to the citrus tree; M. Lr., lemon yellow.

Spheres: 0 9 micron, occurring singly. Gram-positive.

Gelatin colonies: Circular, pale yellow, granular, entire, liquefying in 6 days.

Gelatin stab: Lemon yellow surface growth sinking into the medium. Grayish-white growth in stab. Complete liquefaction in 43 days.

Agar colonies: Small, yellow, smooth, entire.

Agar slant: Broad, lemon yellow, glistening, elastic.

Broth: Turbid, with yellow sediment and pellicle.

Litmus milk: Acid, with slow coagula-

Litmus milk: Acid, with slow coagulation.

Potato: Thin, grayish streak, becoming citron yellow.

Indole not formed.

Nitrites produced from nitrates.

Starch not hydrolyzed.

Acid from glucose, lactose, sucrose,

raffinose, inulin, salicin, glycerol and mannitol.

Does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source

of nitrogen.

Ammonia produced from peptone.

Aerobic, facultative.

Pathogenic.

Optimum temperature 37°C. Source: Originally isolated from pus. Habitat: Skin and mucous membranes of vertebrates

11. Micrococcus aurantiacus (Schroeter) Cohn. (Bacteridium aurantiacum Schroeter, Beitr. z. Biol., 1, Heft 2, 1872, 126; Cohn, Beitr, z. Biol , 1, Heft 2, 1872, 151; Pediococcus aurantiacus De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1839, 1051; Micrococcus aurantiacussorghi Bruyning, Arch. Néer Sci Exact. et Nat., 1, 1898, 297, Streptococcus aurantiacus Chester, Man, Determ Bact., 1901, 69; Aurococcus aurantiacus Winslow and Winslow, Systematic Relationships of the Coccaccae, 1908, 186; Sarcina aurantiaca Holland, Jour Bact, 5, 1920, 225 (not Sarcina aurantiaca Flugge, Die Mikroorganismen, 2 Aufl, 1886, 180), Staphylococcus aurantiacus Holland, sbid ) From Latin, aurum, gold, M. L. aurantium, the orange, M. L., aurantiacus, orange-colored.

Spheres: Slightly ellipsoidal, 1 3 to 1 5 microns, occurring singly, in short chains and in small clumps. Non-motile Gram-positive.

Gelatin colonies: Circular to oval, smooth, glistening with yellow to orange center.

Gelatin stab: Yellow surface growth No liquefaction.

Agar colonies. Circular, smooth, glistening, yellow to orange, entire. Agar slant: Buff to scant orange-yellow,

beaded growth, raised, glistening.

Broth: Turbid, with pellicle

Litmus milk. Faintly acid, no congulation.

Potato: Slimy, yellow growth. Pigment is insoluble in alcohol and ether

Indole not produced.

Nitrites generally produced from nitrates.

Slight acidity from glucose, fructose, sucrose, lactose and mannitol No acid from raffinose, salicin, inulin

Starch not hydrolyzed.

Ammonia produced from peptone No growth in ammonium media. May be pathogenic. Optimum temperature 25°C Aerobic

Source: First isolated from colonies that grew on boiled egg exposed to dust contamination.

Habitat: Usually isolated from infections but also found in milk, cheese and dust.

Note: Albococcus epidermidis (var. A) Kligler (Jour. Infect Dis., 18, 1913, 441) which was based on a white culture received from Kral under the name Micrococcus aurantiacus was apparently a white strain of this organism as it grew luxuriantly on ordinary agar

12. Micrococcus epidermidis (Winslon and Winslow) Hucker (Staphylococcus epidermidis albus Welch, Amer Jour. of Med Sci. Phila., N. S., 162, 1891, 441, Micrococcus epidermidis albus Randolph, Jour Amer Med. Assoc., \$1, 1898, 706, Albococcus epidermidis Winslow and Winslow, Suy. Replationships Coccaceae, New York, 1903, 201, Staphylococcus epidermidis Evans, Jour. Ltd. Dis., 15, 1916, 449, Hucker, N. Y. Agr. Exp. Sta Tech Bull 102, 1924, 21.) From Greek, epidermid, the outer skin.

Spheres 0.5 to 0.6 micron, occurring singly, in pairs and in irregular groups Non-motile. Gram-positive.

Gelatin stab. White surface growth with slow saccate liquefaction

Agar colonies. Rather scant, white, translucent.

Broth: Turbid, with white ring and sediment.

Litmus milk. kcid

Potato · Lamited growth, white.

Indole not formed.

Nitrites are produced from nitrates. Usually does not utilize NII<sub>4</sub>II<sub>2</sub>PO<sub>4</sub> as a source of nitrogen

Acid formed from glucose, fructose, maltose, lactore and sucrose, but not from mannitel, raffinose, salicin or muln.

Usually fails to hemolyze blood No congulase produced,

Parasitic rather than pathogenic. Acrobic, facultative. Optimum temperature 37°C.

Source: Originally isolated from small stitch abscesses and other skin wounds. Habitat: Skin and mucous membranes.

13. Micrococcus Flugge. roseus (Rosafarbiger Diplococcus, Bumm, Der Mikroorganismen der gonorrhoischen Schleimhauterkrankungen, 1 Aufl., 1885. 25; Flugge, Die Mikroorganismen, 2 Aufl., 1886, 183; Neisseria rosea Trevisan. I generi e le specie delle Batteriacee, Milan, 1889, 32; Diplococcus roseus Eisenberg, Bakt. Diag , 3 Aufl., 1891, 12, Merismopedia rosea Dyar, Ann. N. Y. Acad Sci., 8, 1895, 354, Rhodococcus roseus Winslow and Rogers, Jour Inf Dis., 3, 1906, 545.) From Latin, roscus, rosccolored.

Spheres: 1.0 to 1.5 microns, occurring singly and in pairs. Non-motile. Gram-variable.

Gelatin colonies Rose surface growth usually with slow liquefaction.

Agar colonies · Circular, entire, rosered surface colonies.

Agar slant. Thick, rose-red, smooth, glistening streak.

Broth: Slightly turbid with rosecolored sediment.

Litmus milk: Unchanged to alkaline, usually reddish sediment after 14 days. Usually produce nitrites from nitrates. Potato: Raised, rose-red, smooth, glis-

tening.

Starch not hydrolyzed.

Acid from glycerol and mannitol

Utilizes NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of

nitrogen. Saprophytic

Aerobic

Optimum temperature 25°C

Source: Dust contamination Habitat Widespread, as it occurs in dust.

14. Micrococcus cinnabareus Flugge. (Flugge, Die Mikroorganssmen, 2 Aufl , 1886, 174, Rhodeoccus cinnabareus Winslow and Rogers, Jour Inf Dis., 3, 1906, 545.) From M. L, einnabar-colored.

Spheres: 1.0 micron, occurring singly and in pairs. Non-motile. Gram-vari-

Gelatin colonies: Small, circular, bright red, becoming cinnabar red.

Gelatin stab: Thick, raised, rose to cinnabar red growth on surface. No liquefaction. White colonies along stab.

Agar slant: A carmine-red streak. Slow growth.

Broth: Turbid.

Litmus milk: Slightly alkaline to slightly acid.

Potato. Slowly developing vermillion red streak.

Small amount of acid from test sugars. Indole not formed.

Does not utilize NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub> as a source of nitrogen.

Nitrites produced from nitrates.

Starch not hydrolyzed.

Saprophytic.

Aerobic.

Optimum temperature 25°C.

Source. Found as contamination of cultures.

Habitat: Usually found as a dust contamination

15. Micrococcus rubens Aligula. (Micrococcus tetragenus ruber Bujwid, in Schneider, Arb. bakt. Inst. Karlsruhe, I. Heft 2, 1894, 215; Migula, Syst. d. Bakt., 2, 1900, 177; Micrococcus ruber and Rhodococcus ruber Holland, Jour. Bact, 6, 1920, 224; Micrococcus roscofulura Hucker, N. Y. S. Agr. Exp. Sta. Teh. Bull. 135, 1928, 27; not Micrococcus roscofulrus Lehmann and Neumann, Bakt. Diag, 1 Aufl., 2, 1896, 177 and 439; Rhodococcus roscofulrus Pribram, Klassifiation der Schizomyceten, 1933, 44). From Latin, rubens, ruddy.

The following description is taken from Migula (loc. cit.) and from Hucker (loc cit) supplemented from unpublished notes of the latter. Also see Breed (Jour. Bact., 45, 1913, 455).

Spheres · 1.3 to 40 microns, average size 21 microns, occurring in fours and

in irregular masses, generally not singly or in pairs. Non-motile. Gram-negative to Gram-variable

Gelatin colonies: After several days, small, pink or flesh-colored, shiny, butyrous, 0.5 to several mm. in diameter. Smaller colonies have regular edges, larger colonies have lobate edges.

Gelatin streak: Thick, shiny, fleshcolored to carmine-red growth, generally spreading.

Gelaim stab: Scant, whitish growth along line of stab; surface growth fleshred. No liquefaction after several weeks, but a slight softening of the medium underneath the growth.

Agar slant: Luxuriant, thick, spreading, slimy, flesh-colored growth.

Broth: Bright red, slimy sediment.

Milk: Generally acid curd followed by slight pentonization.

Nitrites produced from nitrates

Acid from glucose, sucrose, mannitol

and glycerol No action on lactose or starch.

Pigment soluble in ether, benzol, car-

rignent southe in ether, tenen, cartion bisulfide, chloroform and alcohol Not soluble in water (Schneider, loc cil.).

Saprophytic.

Grows well at 26° to 37°C.

Aerobic.

Source. Original culture isolated by Bujwid in Bern, Switzerland and sent to Migula at Karlsruhe, Germany

Habitat · Unknown.

 Micrococcus rhodochrous (Zopf) Migula. (Rhodococcus rhodochrous Zopf, Berichte d. deutsch. bot Gesellsch, 9, 1891, 22; Migula, Syst. d. Bakt., 2, 1900, 162.) From Greek, rhodum, rose; chros, color.

Spheres: 0 5 to 1 0 micron, occurring singly. Non-motile. Gram-variable.

Gelatin colonies: Small, circular, glistening, raised, entire, dark, reddishbrown. Gelatin stab. Dork, carmine-red, dry surface growth. Slight growth in stab. No liquefaction.

No liquefaction.

Agar slant: Carmine-red streak, becoming brick-red in color.

Broth: Thick rose-red pellicle with red, flocculent sediment.

Litmus milk. Slightly alkaline.

Potato: Carmine-red streak.

Does not ferment glycerol and mannutol.

Aerobic.

Saprophytic.

Optimum temperature 25°C Habitat, Water,

17. Micrococcus agilis A

17. Micrococcus agilis Alı-Cohen. (Ali-Cohen, Cent. f. Bakt , 6, 1889, 36; Planosarcina agilis Migula, in Engler and Prantl, Die naturl Pflanzenfam., 1, la, 1895, 20, Micrococcus agilis ruber Peppler, Cent. f. Bakt., I Abt , 29, 1901, 352. Planococcus agilis Chester, Man. Determ. Bact., 1901, 115, Rhodococcus anilis Winslow and Ropers, Jour. Inf. Dis . 3. 1906, 545; Sarcina agilis Enderlein, Sitzber Gesell, Naturf, Freunde Berlin, 1930, 182; not Sarcina agilis Matzuschita, Zeit. f. Hyg., 55, 1900, 496; not Sarcina agilis Saito, Jour. Coll. Sci Imp. Univ Tokyo, 25, 1908. From Latin, agilis, agile, Spheres, 10 micron, occurring singly,

Spheres, 10 micron, occurring singly, in pairs and in fours. Motile by means of one or two flagella. Gram-variable.

of one or two nagena. Gram-variable.
Gelatin colonies Sinall, gray, becoming
distinctly rose-colored.

Gelatin stab Thin, whitish growth in stab On surface thick, rose-red, glistening growth. Generally no liquefaction.

Agar slant: Glistening, dark rose-red, lobed, much variation in color.

Broth: Slightly turbid, with slight, rose-colored ring and pink sediment.

Litmus milk · Slightly acid, pink sediment.

Potato- Slow growth as small, rosecolored colonies.

Loeffler's blood scrum: Pink, spread-

ing, shiny, abundant. Slow liquefaction.

Indole not formed.

Nitrites produced (trace). Ammonia formed (trace).

Does not utilize NH, H, PO, as source

of nitrogen Acid from glucose, sucrose, inulin, glycerol and mannitol No acid from

raffinoso Aerobic.

Saprophytic.

Optimum temperature 25°C.

Source: Isolated from water. Habitat · Water, sea water, on sea fish

\*18. Micrococcus aerogenes (Schottmuller) Bergev et al. (Staphulococcus aerogenes Schottmuller, Cent f. Bakt., I

Abt., Orig., 64, 1912, 270; Bergev et al., Manual, 1st ed., 1923, 70, not Micrococcus acrogenes Miller. Deutsch Wehnschr., 12, 1886, 119.) From Greek, forming air or gas.

Description according to Prévot, Ann

Sci. Nat., Sér. Bot et Zool., 15, 1933, 212 Spheres: 0.6 to 0.8 micron, occurring in clusters, sometimes in pairs or short

chains. Gram-positive.

Gelatin: No liquefaction.

Deep agar colonies: Small, lenticular, nearly spherical, yellowish white. Some

gas bubbles produced, not fetid. Blood agar colonies: Very small, grayish. No true hemolysis, but a narrow

clear zone is formed. Serum agar: Colonies lenticular not fetid.

Neutral red serum agar Colonies lenticular. Gas produced. Neutral red changed to greenish yellow.

Glucose broth with blood: Turbid. Gas produced. Hydrogen sulfide not produced Slight hemolysis.

Glucose serum broth: Turbid, Gas produced.

Peptone water with serum Gas. Indole produced.

Milk: Growth feeble Neither soid nor coaculated.

Proteins not attacked.

Glucose and fructose attacked slightly by two out of three strains.

Does not plasmolyse readily.

Neutral red broth : Chapred to vellowish green.

Nitrites not produced from nitrates Ontimum pH 6.5 to 80.

Optimum temperature 37°C.

Pathogenic.

Strict angerobe.

Distinctive character: Fermentation of glucose and gas production from pentones.

Source: Isolated (Schottmüller) from cases of puerperal fever. Three strains from infected tonsils studied by Prévot.

Habitat: Natural cavities, especially the tonsils and female genital organs

19. Micrococcus asaccharolyticus (Distaso) comb. nov. (Stanhylococcus asaccharolyticus Distaso, Cent. f. Bakt, I Abt., Orig., 62, 1912, 445 ) From Greek, not dissolving sugar.

Description according to Prévot, Ann. Sci. Nat., Ser. Bot., 15, 1933, 211.

Large spheres: 1.0 to 1.2 microns, occurring in very large clusters, also in pairs and short chains. Gram-positive. Gelatin: At 37°C, growth resembles

tufts of cotton which precipitate. No liquefaction.

Deep agar colonies: Very delicate, pin-point, transparent. A few bubbles of gas produced.

Broth: Turbid. Growth settles at the bottom of the tube as a sort of viscous zooglea. Unpleasant odor produced.

Peptone water: Turbid. Indole produced.

Milk: Feebly acidified, but not coagulated.

Egg white not attacked. Carbohydrates not attacked. Strict angerobe.

<sup>\*</sup> Anaerobic section revised by Dr Ivan C. Hall, New York, N. Y.

Distinctive characters: Large size; unpleasant odor; production of indole; production of gas.

Source: Isolated from the large intestine of a man with intestinal in-

toxication.

Habitat; Intestine. Not common

Nora: Weinberg, Nativelle and Prévot (Les Microbes Amérobies, 1937, 1023) regard Micrococcus infolicus Christiansen (Ac. Pat. Mier. Scand., 18, 1931, 42) as a vitriety of this species giving it the name Slaphylococcus asaccharolyticus var indolicus. This variety differs from the species by forming opque lens-shaped colonies and by a more abundant production of gis from pentone

20. Micrococcus niger Hall (Jour Bact., 20, 1930, 409) From Latin, niger, black.

Small spheres: 0.6 micron in diameter, occurring in irregular masses, occusionally in pairs. Gram-positive

Gelatin: After 5 days a dark sediment is produced which gradually gets more and more intensely black. No inquefaction.

Deep agar colonies Slow growth 't first very tiny, colorless, tregularly globular, amouth, dense Small hubbles of gas sometimes produced 'ther several days colonies become brown, then black. If exposed to air, colonies fade to a dull gray. Medium not discolored

Blood agar shut. Mer t or 5 days minute, black colonies, round, smeath, glastening, 0.5 mm, in diameter. Nonhemolytic.

Broth: After 1 or 5 days uniform turladity and slight production of gas which contains H.S. Black sediment

Congulated serum Minute, brown colonies appear on the 5th day No figuefaction

Milk No change

Brain nodum Turbid after 4 or 5 days at 37°C. Uniform gas profection shout the 6th day. Discolarston of the medium not marked. No acid from carbohydrates. Black sediment produced.

Non-pathogenic for guinea-pigs and rabbits.

Optimum temperature 37°C. No growth below 30°C.

Strict anaerobe.

Distinctive characters: Formation of a water-insoluble, black pigment. Growth slow, visible after 2 to 4 days.

slow, visible after 2 to 4 days.

Source: Isolated from urine of an aged woman.

Habitat: Unknown.

21. Micrococcus grigoroffi Prévot. (Vicrococcus A, Grigoroffi, Thèse de Geneve, 1905; Prévot, Ann. Sci. Nat., Sér Bot. et Zool, 15, 1933, 219.) Named for Grigoroff, who first isolated this organism.

Small spheres: Average size 0.7 micron, occurring singly or in irregular masses. Gram-positive.

Gelatin Colonies appear in four days

No liquefaction.

Deep agar colonies: After three days.

round, lenticular, yellowish
Glucose broth Turbid after 2 days
with whitish sediment Neither gas
nor fettid odor produced. The medium
is acidified.

Milk: Good growth Acid. Congu-

Acid from glucose, maltose, lactose, fructose and sorbitol

One strain slightly pathogenic

Optimum temperature 37°C

Strict anaerobe Distinctive characters. This is the

only anaerobic coccus growing in irregular masses that congulates milk. Inclose is fermented

Source Five strains is dated from the appendix by Grigoro'l. One strain isolated from an appendix by Privot.

Habitat Human digestive tract. Not

22 Mitrococcus anaerobius (Hamm) c no nor (Anaerobic stephyl morcus Jurgero, Compt rend Soc Bod Paris, 52, 1907, 707; Staphylococcus anaerobius Hamm, Die puerperale Wundinfektion, Berlin, 1912, not Staphylococcus anaerobius Heurlin, Bakt. Unters. d. Keingehaltes im Genitalkanale d. fiebernden Wochnerinnen, Helsingfors, 1910, 120.) From Greek, living without air.

Description according to Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 209.

Small spheres: 0.5 to 0.6 micron, occurring in masses. Gram-positive. Gelatin: No liquefaction.

Deep agar colonies: Lenticular, thick. No gas produced.

Broth: Turbid, later clearing. Sediment.

Glucose broth: Good growth. Neither acid nor gas produced.

Peptone water: No turbidity. No gas. Indole not produced.

Milk: Neither coagulated nor acidified. Coagulated serum not attacked. Egg white not attacked. Carbohydrates not attacked by the strains of Jungano. Acid feebly produced from glucose and galactose by Prévot's strain.

Does not plasmolyse.

Temperature relations: Optimum 36° to 38°C. At 22°C growth slow, poor. No growth below 22°C. Killed in ten minutes at 80°C or in half an hour at 60°C.

Optimum pH 60 to 8.0.

Pathogenic for guinea-pigs and rabbits.

Strict anaerobe.

Distinctive characters: Neutral red broth remains unchanged. No gas produced.

Source: First isolated by Jungano from a case of cystitis. Found by Prévot in the pus from a suppurated tonsil.

Habitat: Urinary tract, urethra, intestine, buccal cavity and conjunctiva

Appendix I\*: The following genus is organized on a physiological basis. Because of this no attempt is made to fit it into the classification outline. A single species has been described.

## Genus A. Methanococcus Kluyver and van Niel.

(Cent. f. Bakt., II Abt., 94, 1936, 400.)

Spherical cells, occurring singly or in masses. Motility not observed. No endospores formed. Gram-variable. Chemo-heterotrophic, anaerobic, fermenting various organic compounds with the formation of methane. Saprophytes.

The type species is Methanococcus mazer Barker.

1. Methanococcus mazel Barker. (Pseudosareina, Mazé, Compt rend. Soc. Biol., Paris, 78, 1915, 398; Barker, Arch. f Mikrobiol., 7, 1936, 430) Named for Mazé, the French bacteriologist who first gave a clearly recognizable description of this type of methane organism.

Small spherical cells, occurring singly, in large, irregular masses, or in regular cysts of various sizes and forms. Nonmotile. Stains readily with crythrosine. Gram-variable

Grows on calcium acetate enrichment media and ferments the acetate vigorGrows slowly on agar containing 2 per cent clear mud extract.

Ferments acetic and butyric acids with production of methane in the presence of CO<sub>2</sub> Ethyl and butyl alcohols not attacked.

Does not utilize organic nitrogen. Obligate anaerobe.

Grows best at 30° to 37°C.

Sources: Garden soil, black mud containing H<sub>2</sub>S, feces of herbivorous animals.

Habitat: One of the most active methane-producing organisms found in nature.

<sup>\*</sup>Appendixes I and II prepared by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, December, 1943.

Appendix II: The following genus is recognized by workers in the brewing industry. It includes species that present characters intermediate between Micrococcus, Sarcina and Streptococcus Many students prefer to regard these as species of Micrococcus (Hucker, N. Y. State Exper. Sta, Tech Bul. 102, 1921, 5), of Sarcina (Macé, Traité pratique d. Bact., 4th ed., 1901, 460) or of Streptococcus (Shimwell, Sect. 670 in Hind, Brewing Science and Practice, New York, 1940). Others (Mees, Thesis, Delft, 1931) would include in the genus, the species described as Tetracoccus by Orla-Jensen (The Lactic Acid Bacteria, Copenhagen, 1919, 76).

Genus B. Pediococcus Balche (Wehnschr. f. Brauerei, 1, 1884, 257.)

Cocci occurring singly, in pairs and tetrads. Non-motile. No endospores. Grampositive. Facultative anaerobes under favorable conditions, especially in acid media. Nitrites not produced from nitrates. Produce acidification and more or less clouding of wort and beer. Suprophytes.

The type species is Pediococcus cerevisiae Balcke.

1. Pediococcus cerevislae Balcke. (Ferment No. 7, Pasteur, Études sur la bière, Paris, 1876, 4; Sarcina Balcke, Wchuschir. f. Brauceci, f. 1884; 183; told, f. 1834; 297; Merismopedia acrevisiae Dyar, Ann. N. Y. Acad Sci. 8, 1805, 318; Micrococcus ceresisuae Migula, Syst d Bakt, 2, 1900, 77; Sarcina cerevisiae Macé, Traité Pratique d Bact., 4the d, 1901, 400) From Latin, cerevisia, beer

Spheres: 1 to 1.3 microns, occurring singly, in pairs or tetrads. In acid media the latter prevail. Catalase negative. Non-motile. Gram-positive

No growth in alkaline media.

Peptone, meat-extract gelatin. White becoming yellowish to yellowish brown. No liquefaction.

Wort gelatin with Ca-carbonate: White colonies, 2 to 3 mm; carbonate dissolved

Meat extract gelatin stab: Growth along stab, white raised surface growth No liquefaction.

Litmus milk: No growth.

Potato: Scanty growth.

Acid from glucose, fructose, maltose, sucrose.

Wort and beer Slight to moderately turbid growth, strong development on bottom of the flask. Hop sensitive, but may develop in heavily hopped beers under special conditions. Does not utilize urea.

Nitrites not produced from nitrates. Facultative anaerobic.

Killed at 60°C in 8 minutes. Optimum temperature: 25°C.

Source: Sarcina-sick beer,

Habitat: Wort, beer and beer yeast.

Additional species have been described from spoiled wort and beer which vary but slightly from the species first named and described by Balcke. These are lasted below together with other species that have been placed in the genus.

Peducoccus acaidactici Lindner. (Lindner, Wehnschr. f. Brunerci, S. No. 23, 1837, see Cent. f. Bakt., £, 1837, 312; also see Die Sareina-Organismen der Gährungsgewerbe, Lindner, Inaug. Diss, Berlin, 1838, 29, and Cent. f. Bakt., 4, 1858, 429, Micrococcus pseudocerecisies Migula, Syst. d Bakt., 2, 1900, 77; Micrococcus sendi-lactici Chester, Man. Determ. Bact., 1901, 88) From spoiled mash

Pediococcus albus Lindner. (Die Sarcina-Organismen der Gährungsenerbe, Lindner, Inaug. Diss., Berlin, 1887, 39; see Cent. f. Bakt., 4, 1888, 429; Micrococcus preudostrena Migula, 59xt. d. Bakt., 2, 1900, 92; Micrococcus albus Chester, Man Determ. Bact., 1901, 97.) From spoiled beer.

Pediococcus damnosus Claussen.

(Compt. rend. Trav. Labor. de Carlsberg, 6, 1906, 68; Streptococcus damnosus Shimwell and Kirkpatrick, Jour. Inst. Brewing, 45, 1939, 137.) From clear, spoiled beer.

Pediococcus halophilus Mecs. (Tetracoccus No. 1, Orla-Jensen, The Lactic Acid Bacteria, 1919, 77; Mecs, Thesis, Delft, 1934, 94.) From anchovy pickle.

Pediococcus hennebergi Sollied. (Ztschr. Spiritusindus., 26, 1903, 491.) From spoiled beer.

Pediococcus kochii Trevisan. (Mikrokokkus in Wundsecreten bei Menschen, Koch; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 28.)

Pediococcus pentosaceus Mees. (Tetracoccus No. 2, Orla-Jensen, The Lactic Acid Bacteria, 1919, 78; Mees, Thesis, Delft, 1934, 94.) From yeast.

Pediococcus perniciosus Claussen (loc. cit.). From clouded, spoiled beer.

Pediococcus sarcinaeformis Reichard. (Ztschr. f. d. ges. Brauwesen, 17, 1894, 257.) From spoiled beer.

Pediococcus urinae equi Mccs. (Pfordeurinsarcina, von Huth, Alg Ztg. f Bierber u. Malzfabr, 185, 968 and 981, 1885; ibid., 1886, 141; Mccs, Thesis, Delft, 1934, 95.) From horse urine.

Pediococcus violaceus (Kūtzing) Trevisan. (Merismopedia violacea Kutzing; Trevisan, I generi e le specie delle Batteriacee, Milan. 1889, 28.)

Pedioplana haeckeli Wolff. (Cent. f Bakt., II Abt., 18, 1907, 9.) Motile. From rotting beets. Placed in a new genus Pedioplana Wolff (loc. cit., 9).

Streptococcus damnosus var. mucosus Shimwell. (Shimwell, Sect. 670, Hind, Brewing Science and Practice, New York, 1910.) From ropy beer.

Appendix III\* The following species have been found in the literature and are listed here chiefly for their historical interest. Many are incompletely described, while many others are identical

with previously described species. See Monographs by Winslow and Winslow, Systematic Relationships of the Cocaccacae, 1903 and Hucker, N. Y. State Exper. Sta., Tech. Buls. Nos. 99-103. References are to Tech. Bul. 102.

Ascococcus cantabridgensis Hankın. (Quoted from Lehmann and Neumann, Bakt. Diag., 2 Auß., 2, 1899, 165.) Migula (Syst. d. Bakt., 2, 1900, 193) reports he is unable to find further reference to this organism and we likewise are unable to trace it. From the human mouth.

Ascococcus gangrenosus Bevan. (Med. News, No. 1003, 1892, 375; Abst. in Cent. f. Bakt., 18, 1893, 796.) From a gangrenous foot.

Ascococcus vibrans van Tieghem. (Bul. Soc. Bot. France, 27, 1880, 150.) From water.

Aurococcus tropicus Chalmers and O'Farrell. (1913, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 931.) Found in Ceylon in granulating ulcers of skin.

Coccus carduus Heurlin. (Bakt. Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wochnerinnen Helsingfors, 1910, 136.) Anaerobic. From genital canal

Coccus caudatus Heurlin (loc. cit., S4). From genital canal.

Coccus vaginalis Heurlin (loc. cit., 79). From genital canal.

Galactococcus albus Guillebeau. (Landwirtsch. Jahrb. d. Schweiz, 4, 1892, 27; Abst. in Cent. f. Bakt., 12, 1892, 101.) From milk from an inflamed udder.

Galactococcus fulvus Guillebeau (loc. cit.). From milk from an inflamed udder Galactococcus versicolor Guillebeau (loc. cit.). From milk from an inflamed udder.

Gyrococcus flaccidifex Glaser and Chapman. (Science, 56, 1912, 219.) Isolated from the gypsy moth, Porthetria dispar-Jodococcus taginatus Miller. (Miller,

Prepared for Prof G. J. Hucker by Mrs. Eleanore Heist Clise, New York State Experiment Station, Geneva, New York, March, 1943.

Mikroorganismen der Mundhöhle, 1889, 51; Baclerium 10genum Baumgartner, Ergebnisse d. ges Zahnbeilk , Heft 2, 1910, 729; Abst. in Cent f. Bakt., I Abt , Ref., 48, 1911, 621) From the oral

Merismopedia aurantiaca Maggiora cavity. (Giorn. Soc. Ital. d'Igiene, 11, 1889, 351, Abst. in Cent. f Bakt, 8, 1890, 13) From the normal skin of the human foot

Micrococcus achrous Migula (No. 16, Lembke, Arch. f. Hyg, 26, 1896, 310, Migula, Syst. d. Bakt, 2, 1900, 201) From feces. Winslow and Winslow (Systematic Relationships of the Coccaceae, 1908, 221) state that this species is apparently a synonym of Micrococcus candi

Micrococcus acidi lactici Marpmann cans Flugge. (Ergunzungsheft d Cent f. allg Gesund heitspflege, 2, 1886, 22 ) Found in fresh

Micrococcus acidoloraz Muller-Thur milk. gau and Osternalder. (Cent f Bakt, II Abt., 56, 1913, 236) From wine را وم Hucker (loc. cit., 6) considers this it 710 \$ synonym of Micrococcus luteus Cohn or dala-

Micrococcus tarians Migula Holland (Jour Bact., 5, 1920, 223; Staphylococcus acne Holland, thid., 225, see Micrococcus cutis

communis Sabouraud ) Micrococcus (Staphylococcus) acridi cula Kufferath. (Ann. de Gembloux, 27, 1921, 253.) Isolated from diseased locusts from Greece. Resembles Micro-

Micrococcus acrius Chester (No 19, coccus aureus Zopl. Conn, Storrs Agr Exp Sta. 7th Ann Rept., 1895, 81; Chester, Man Determ Hucker Bact , 1901, 101 ) From dust (foc. cit , 12) states that this species appears to be identical with Micrococcus

Micrococcus aerogenes Miller. (Miller, aureus Zoni. Deutsche med Wehnschr , 12, 1886, 119, not Vicrococcus aerogenes Bergey et al , Manual, 1st ed , 1923, 70 ) From the ahmentary canal

Micrococcus agilis albus Catterina. (Cent. f. Bakt., I Abt., Orig., \$4, 1903, 108) Found in septicemia of rabbits Motile with one or two flagella.

Micrococcus albaius Kern. (Arb bakt. Inst Karlsruhe, 1, Heft 4, 1897, 479.) From the intestine of a woodpecker (Picus major). Winslow and Winslow (Systematic Relationships of the Coccaceae, 1908, 199) state that this species appears to be a synonym of Micrococcus albus Schroeter; while Hucker (N. Y. Agr Exper. Sta., Tech. Bull. 102, 19) regards it as a synonym of Micrococcus freudenreichis Guillobeau or Micrococcus ureae Cohn.

Micrococcus albescens Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 76 ) From cheese Winslow and Winslow (loc cil , 199) state that this species appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit, 19) regards it as a synonym of Micrococcus freudenreichts Guillebeau or of Macrococcus ureae Cohn. (Losski.

Micrococcus albidus Losski Inaug Dies., Dornat, 1893, 55; not Micrococcus albidus Henrici, see Micrococcus subnueus below, not Micrococcus albidus Roze, Compt. rend Acad. Sci. 123, 1896, 750) From soil. Hucker (for cit , 19) regards this species Paris, as a synonym of Micrococcus freudenreichts Guillebeau or Micrococcus ureae Colin

Micrococcus albocereus Migula phylococcus cereus albus Passet, Untersuch u d Actiol d eiterigen Phlegmone d Menschen, Berlin, 1895, 53, and Fortschr d Med , 3, 1885; Micrococcus cercus albus Flügge, Die Mikroorganismen, 2 Aufl . 1886, 182, Staphylococcus cercus Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32, Migula, Syst. d Bakt . 2, 1990, 56, Staphylococcus cereus-albus Holland, Jour. Bact , 5, 1920, 225 ) From human pus, also from water Winslow and Winslow (Systematic Relationships of the Cocenceae, 1908, 205) consider this a synonym of Micrococcus

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e factibult Charte Rev. 50. 1917 30 64 ner, on the Persons t candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus albus Frankland and Frankland. (Phil. Trans. Roy. Soc., London, 178, B, 1888, 264; not Micrococcus albus Matzuschnta, Cent. f. Bakt., I Abt., 29, 1901, 362; not Micrococcus albus Buchanan, Veterinary Bacteriology, 1911, 196; not Micrococcus albus Macé, Traité Pratique de Bact., 6th éd., 1912, 605.) From air. Resembles Micrococcus candicans.

Micrococcus albus II Maggiora. (Cent. f Bakt., 8, 1890, 13.) Sce Micrococcus opalescens De Toni and Trevisan. From the skin of the human foot.

Micrococcus amplus Migula. (Grauweisser Diplococcus, Bumm, Der Mikroorg. d. gonorth. Schleimhauterkrank.,
1 Aufl, 1885, 17; Micrococcus albicans
amplus Flugge, Die Mikroorganismen, 2
Aufl., 1886, 183; Neisseria albicans
Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Diplococcus
albicans amplus Eisenberg, Bakt. Diag,
3 Aufl., 1891, 24; Migula, Syst. d Bakt.,
2, 1900, 118; Micrococcus albicans Chester,
Man. Determ. Bact. 1901, 80). From
vaginal secretions. Hucker (loc cit.,
15) considers thus species identical with
Micrococcus albus Schrocter

Micrococcus ampullaceus Kern. (Arb. bakt. Inst Karlsruhe, I, Heft 4, 1897, 477.) From the intestine of a dove (Columba cenas) Hucker (loc cit., 19) considers this a synonym of Micrococcus freudenreichti Guillebeau or Micrococcus ureae Cohn.

Micrococcus annulatus Kern (loc. cit., 490). From the stomach contents of the hedge sparrow (Passer montanus) and the intestine of the rock dove (Columba luvia). Winslow and Winslow (Systematic Relationships of the Coccace, 1908, 216) consider this species a synonym of Micrococcus flavus Lehmann and Neumann.

Micrococcus aquatilis Bolton. (Zschr. f. Hyg., 1, 1886, 94; not Micrococcus aquatilis Chester, see below.) From

water. Winslow and Winslow (loc. cit., 224) state that this species is apparently a synonym of Micrococcus candicans Flurge.

Micrococcus aquatilis Chester. (Micrococcus aquatilis invisibilis Yaughan, Amer. Jour. Med. Sci., 104, 1892, 183; Chester, Man. Determ. Bact., 1901, 88.) From water. Winslow and Winslow (loc. cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flinger.

Micrococcus aquatilis albus. (Quoted from Toporoff, Protok. d. Kaiserl. kaukasisch Mediz. Gesellsch., 1892, No. 21; Abst. in Cent. f. Bakt., 18, 1893, 487.) From water.

Micrococcus aquatilis flavus. (Quoted from Toporoff, loc. cit.) From water.

Micrococcus aqueus Migula. (No. 25, Lembke, Arch. f. Hyg., £6, 1896, 317, Migula, Syst. d. Bakt., £, 1909, 201) From feces. Winslow and Winslow (loc. cit., 184) state that this species is apparently a synonym of Micrococcus aureus Zopf, while Hucker (loc. cit., 15) regards this as a synonym of Micrococcus albus Schroeter.

Micrococcus arborescens lactis Con(Conn, Storrs Agr. Exp. Sta. 12th Ann
Rept., 1909, 46; Micrococcus lactis arborescens Conn, Esten and Stocking,
Storrs Agr. Exp. Sta. 18th Ann. Rept.,
1907, 110.) From milk. Hucker (leccit., 21) regards this as a synonym of
Micrococcus candidus Cohn or Micrococus epidermidis Hucker.

Micrococcus argenteus Migula. (No. 27, Lembke, Arch. f. Hyg., 26, 1809, 317. Migula, Syst. d. Bakt., 2, 1909, 20c.) From feecs. Winslow and Winslow (loc. cit., 184) state that this species is apparently a synonym of Micrococcus aureus Zopf, while Hucker (loc. cit., 10) considers it a synonym of Micrococcus considers it a synonym of Micrococcus considers it a synonym of Micrococcus considers and Migula.

Micrococcus ascoformans Johne. (Zoogloea pulmonis equi Bollinger, Arch. f. path. Anat., 49, 1870, 583; Discomyces equi Rivolta, Giorn. di Anat. e Fisioles, 10. 1884: Johne, Ber. u. d. Veterin, im Komer, Sachsen Jahr 1885 47: Ascococcus sohnei Cohn in letter to Johne Doutsche Ztschr. f. Thiermed 12 1886 210: Micrococcus botruogenus Rabe. Dout Ztschr. f Thiermed , 12, 1886, 137; Botryomyces eaux Bollinger. Ztschr. f. Thiermed., 13, 1887, 176, Rollygeoreus ascaformans Kitt Cont f Bakt , S. 1888, 217. Bollingera cour Trevisan. I generi e le specie delle Batteriacee, Milan, 1889, 26. Stanhulococcus ascoformans Ford, Textb of Bact . 1927. 424: Staphulococcus aureus var equi Handurov et al Diet d Bact Path 1937. 501.) Causes botryomycosis in horses. Lehmann and Neumann (Bakt Diag., 7 Aufl. 2, 1927, 291) consider this a form of Micrococcus aureus Zonf, while Hucker (loc cit , 15) regards this as a form of Micrococcus albus Schroeter

Micrococcus ascoformis Fermi. (Arch f. Hyg., 10, 1800, 10.) Presumably intended for Micrococcus ascoformans Johne

Micrococcus asper Migula (Seibert, Inaug. Diss., Wurzburg, 1894, 12, Migula, Syst. d Bakt, 2, 1900, 82) From a hairbrush Winslow and Winslow (doc. et al., 203) consider this species to be a synonym of Micrococcus candidus Cohn or of Gaffha, tetragena, Trevysan

Micrococcus aurantiacus-sorghi Bruyning. (Arch. Néer. Sci. Exact et Nat. 1, 1898, 297; Streptococcus aurantiacus Chester, Man Determ Bact., 1901, 69.) From sorghum.

Micrococcus aureus Chester (Micrococcus cremodes aureus Dyar, Ann N Y Acad. Sci. 8, 1895, 219, Chester, Manual Determ. Baet., 1991, 99) From dust. Regarded by Dyar as a varietal form of Micrococcus cremoids Zummermann Winslow and Winslow (doc. ct.), 181) consider this species a synonym of Micrococcus aureus Zopf

Micrococcus aureus lactis Conn (Storrs Agr. Exp. Sta 12th Ann. Rept , 1900, 36.) From milk. This seems to be identical with Micrococcus lactis aureus 1, Conn, Esten and Stocking, Storrs Agr. Exper. Sta 18th Ann. Rept., 1907, 119. Hucker (loc. cit., 9) regards this species as identical in part with Micrococcus flavus Lehmann and Neumann and with Micrococcus condomeratus Micro

Mirrococcus congomeratus Aiguta.
Mirrococcus (Sarana) bacatus Migula.
(No 18, Lembke, Arch f Hyg. 28, 1806, 311; Migula, Syst. d. Bakt., 2, 1900, 202.)
From feces. Winslow and Winslow (doc. ct., 232) state that this is a yellow, gelatin-liquelying sarena, apparently a synonym of Sarcina flata De Bary. Hucker (doc. ct., 10) considers this a synonym of Mirrococcus conglomeratus Migula.

Merococcus badius Lehmann and Neumann (Bakt Ding 1 Aufin, 2, 1856, 163) Received from the Kral collection as Sarcina lutea Winslow and Winslow (loc cit, 216) consider this a synonym of Micrococcus flavus Lehmann and Neumann

Micrococcus baregensis purpureus Robine and Hauduroy. (Compt. rend Soc. Biol, Paris, 08, 1928, 25.) From hot sulfur springs at Barèces.

Micrococcus beigelii (Rabenhorst) Migula (Pleurococcus beigelii Kuchenmerster and Rabenhorst, Hechwiga, 1867, No 4, Sclerotum beigelianum Haller, 1888, Zoogloca beigeliana Eberth, 1873; Hyalococcus beigelii Schroeter, Kryptog.-Flora v Schlesien, 8, 1, 1886, 152; Chlamydalomus beigelii Tevenan, Rendiconti Reale Inst Lombardo de Sci. e Lett, Ser. II, 12, 1879, 22; Migula, Syst. d Bakt. 2, 1900, 193; Trickosporum beigelii Vullemin, 1901) From human

Micrococcus beri-beri Pekelharing, (Pekelharing, Weekblad v. h. Ned. Trjdschr v. Gencesk., No 25; also Pekelbaring and Winkler, Deut med. Wehnschr, No 39, 1887, 845; Aresseria veinkleri Trevisan, I generi e le specie delle Batterracee, Milan, 1889, 32.) Considered the cause of beri-beri by Pekelharing Winslow and Winslow (Ioc. ett., 184) state that this is apparently a synonym of Micrococcus aureus Zopf; while Hucker (Ioc. ett., 11) considers

this a synonym of Micrococcus citreus Migula.

Micrococcus bicolor Kern. (Arb. bakt. Inst. Karlsrube, 1, Heft 4, 1897, 485.) From the intestine of a dove (Columba cenas). Hucker (loc. cit., 21) considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidermidis Hucker.

Micrococcus billrothii (Cohn) Migula. (Ascocccus billrothii Cohn, Beitr. z. Biol. d Pflanzen, 1, Heft 3, 1875, 151; Migula, Syst. d. Bakt., 2, 1900, 195.) Found in putrefying meat infusion.

Micrococcus biskra Heydenreich. (Heydenreich, Ausgabe d. Haupt Med.-Verhalt., St. Petersburg, 1888; see Cent. f. Bakt., 5, 1889, 163; Staphylococcus biskrae Trevisan, I genere e le specie delle Batteriacce, Milan, 1889, 32; Micrococcus heydenreichis Chester, Man. Determ. Bact., 1001, 91) Found in ulcers in an Oriental skin disease. Winslow and Winslow (loc. cit., 184) state that this is apparently a synonym of Micrococcus aureus Zopf, while Hucker (loc. cit., 11) considers it a synonym of Micrococcus citicus Migula.

Micrococcus boleti Passerini (Erbar. crittogam. Italiano, II sor, No. 1193; quotod from Trevisan, I generi e le specie delle Batteriaceo, Milan, 1889, 34) Saprophytic on a Iungus (Boletus edulis).

Micrococcus bombycis (Naegeli) Cohn. (Panhistophyton ovatum Lebert, Jahresber ü. d. Wirksamkeit d Vereins z. Beförd. d. Seidenbaues f. Brandenburg im Jahre 1856-57, 28; and Berliner Entomolog Ztschr., 1858; Nosema bombycis Nacgeli, Botan. Sect. d. 33 Versammlg d. Naturf. u. Aerzte in Bonn, 1857, 160: and Botan Zeitg., 1857, 760; Microzyma bombyers Béchamp, Compt. rend Acad. Sci., Paris, 64, 1867, 1015; Cohn, Beitr. z. Biol. d. Pflanzen, 1, Heft 2, 1872, 165; Micrococcus oratus Winter, in Rabenhorst, Krypt. Flora v. Deutschl., Oesterr. u. d. Schweiz, 2 Aufl , 1, 1884, 47; Streptococcus bombycis Zopf, Die Spaltpilze, 2 Aufl., 1884, 52.) Found in the blood and organs of diseased silkworms (Bombyz mori).

Micrococcus boreus Issatchenko. (Recherches sur les Microbes de l'Ocean Glacial Arctique, Petrograd, 1914, 143.) From sea water.

Micrococcus bovinus Migula. (Micrococcus der Lungenseuche der Rinder, Poels and Nolen, Fortschr. d. Med, 1886, 217; Migula, Syst. d. Bakt., \$, 1900, 67:) From the lungs of diseased cattle. Hucker (loc. cit., 22) regards this a synonym of Micrococcus candulus Cohn or of Micrococcus epidemidis Hucker.

Micrococcus bows Migula. (Hematococcus, Babes, Compt. rend. Acad. Sci., Paris, 107, 1888, 692 and 110, 1899, 809 and 975; also see Arch. f. path. Anat, 115, 1889; Neisseria babesi Trevisan, I generi e le specie delle Batteriae, Milan, 1889, 32; Haematococcus bort Eisenberg, Bakt. Diag., 3 Aufl., 1891, 271; Migula, Syst. d. Bakt., 2, 1903, 55 From the blood and organs of cattle.

Micrococcus burchardti Trevisa. (Coccus bei keratitis phlyctaenules. Burchardt, Cent. f. Bakt., f, 1837, 39; Trevisan, I generi e le specie delle l'atteracee, Milan, 1889, 33.) Pathogenic From the cornea of a rabbit.

Micrococcus butyri (v. Klecki) Miguls (Diplococcus butyri von Klecki, Cent I. Bakt., 16, 1894, 358; Migula, Syst. d. Bakt., 2, 1900, 216.) From rancid butter. Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus butyri fluorescens Teichert (Inaug. Diss., Jena, 1904; Abst. in Cent f. Bakt., II Abt., 13, 1904, 561.) From milk. Exhibits a green fluorescence.

Micrococcus bulyricus (von Klecki)
Migula. (Tetracoccus bulyricus va Klecki, Cent. f. Bakt., 15, 1801, 301, Migula, Syst. d. Bakt., 2, 1900, 216) From rancid butter. Winslow and Wiaslow (loc. cit., 220) consider this a syaonym of Micrococcus luteus Cohn. Micrococcus calco-aceticus Beijerinck. (Proc. Sect. Sci., Kon. Akad. v. Weten-schappen, 15, 1911, 1066; Abst. in Cent f. Bakt., II Abt., 51, 1912, 290.) Occurs commonly in soils.

Micrococcus campeneus Orme. (Jour. Trop Med. and Hyg., 11, 1908, No 10, May 15; Abst. in Cent. f Bakt, I Abt,

Ref , 45, 1909, 299.)

Mitroocecus candicens Flugge (Die Mitroocecus candicens Winslow and Rigores, Jour. Inf. Dis., 5, 1996, 544, Staphylococcus candicens Holland, Jour Bact, 5, 1920, 225.) From air, water and milk. Hucker (loc ett, 22) regards this a synonym of Microeccus candicus Cohn or of Microeccus epidermidis Hucker. For a description of this species, see Bergey et al., Manual, 5th ed., 1930, 255.

Micrococcus canescons Migula (Micrococus No. 4, Adanett, Landwittsch Jahrb., 18, 1889, 240; Migula, Syst d Bakt., 2, 1900, 51; Albococcus canescens Winslow and Rogers, Jour Inf Dis., 3, 1906, 541; Staphylococcus canescens Holland, Jour. Bact., 5, 1920, 225) From Emmenthal cheese. Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Micrococcus candicans Fluvee.

Micrococcua capillorum (Buhl) Trevisan. (Zoogloea capillorum Buhl, Zischr. f. ration. Med., II Reihe, 44, 18-356; Palmella capillorum Ruhn, Abhandl d. Naturf Ges zu Halle, 9, Hieft. 1, 8-62, Palmellina capillorum. Rabenhorst, Flor. Eur. Alg., 3, 1856 (?), 35, Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33) From the skin Considered nathogenic.

Micrococcus capsaformans Jamicson and Edington. (Brit. Med. Jour, J. June 11, 1887, 1262; Micrococcus caprtforms (sec), Abst in Cent. f. Bakt., 2, 1887, 223.) From the scales and blood of scarlet fever patients Not pathogenic

Micrococcus carbo Renault. (Compt rend. Acad. Sci., Paris, 123, 1896, 935) Micrococcus carneus Zimmermann.
(Roter Coccus, Maschek. Bakt. Untersuch d. Leitumeritz. Trinknassers, No.
5, 1887, 60; Zimmermann, Die Bakt.
unscrer Trink- u. Nutzwässer, Chemnitz, I Reihe, 1890, 78.) From water.
Hucker (loc. cil., 25 and 26) regards
this species as identical with Micrococcus
roseus Flugge or Micrococcus cinnabareus Flugge

Micrococcus carnicolor Frankland and Frankland. (Phil. Trans. Roy. Soc. London, 178, B, 1888, 263, not Micrococcus carnicolor Kern, see Micrococcus subcarneus below.) From air. Hucker (loc cit, 25) states that this species may be identical with Micrococcus rosets Filters.

Micrococcus carniphilus Wilhelmy. (Arb bakt. Inst. Karlsruhe, 3, 1903, 10.) From a meat extract.

Micrococcus casei amari edamicus Raamot. (Inaug. Diss., Kõnigsberg, 1906; Abst. in Cent. f. Bakt., II Abt., 18, 1907. 348.) From nasteurized skim milk

Micrococcus castellanii Chalmers and O'Farrell. (Ann Trop. Med. and Pamstol. 7, 1913, 528; Rhodococcus castellanii Castellanii and Chalmers, Man. Trop. Med. 3rd ed., 1919, 2102.) Found in the red variety of trehomycosis axillarıs, a tropical disease.

Micrococcus cartharinensis Issatchenko. (Recherches sur les Microbes de l'Oceán Glacial Artique, Petrograd, 1914. 148.) From sea water.

Micrococcus cellaris (Schroeter) Migula (Leucocystis cellaris Schroeter, Kryptog Flora v. Schlesien, 5, 1886, 182; Migula, Syst d. Bakt, 2, 1900, 195.) From a coating on the walls of damp cellars and mines

Micrococcus centropunctatus Issatchenko. (Recherches sur les Microbes de l'Oceán Glacial Arctique, Petrograd, 1914, 146.) From sea water.

Micrococcus cerasinus Migula (Micrococcus aus roter Milch, Keferstein; Cent. f. Bakt., I Abt., 21, 1897, 177; Micrococcus cerasinus lactis Heim, Lehrb. d. Bakt, 2 Aufl., 1898, 299; Migula, Syst d. Bakt, 2, 1900, 170; not Microoccus corasurus Lehmann and Neumann, Bakt. Diag, 1 Aufl, 2, 1896, 179; Micrococcus keferstenni Chestor, Man. Daterm. Bact., 1901, 197.) From red milk. Hucker (loc cit., 20) regards this species as identical with Micrococcus cinnabareus Filipre.

Micrococcus cereus Migula. (Staphylococcus cereus flavus Passet, Untersuchungen über die Aetiologie der eiterigen Phlegmone des Menschen, 1885, 53; Micrococcus cereus flavus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 182; Staphylococcus passeti Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Migula, Syst. d. Bakt., 2, 1900, 126; Staphylococcus cereus-flavus Holland, Jour. Bact., 5, 1920, 225 ) From pus. Winslow and Winslow (loc. cit. 220) consider this species identical with Micrococcus luteus Migula. For a description of this organism, see Bergey et al., Manual, 5th ed., 1939, 241,

Micrococcus cereus aureus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 347.) Obtained as Staphylococcus cereus aureus from Kral's laboratory: also found in air.

Micrococcus cerinus Henrici. (Arb. bakt. Inst Karlsruhe, 1, Heft 1, 1894, 84) From Swiss cheese. Winslow and Winslow (Ioc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan.

Mitrococcus chersonesia Corbet. (Quart. Jour. Rubber Research Inst, Malaya, 2, 1930, 150.) From the latex of the rubber tree (Hevea brasiliensis). For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 258.

Micrococcus chinicus Emmerling and Abderhalden. (Cent. f. Bakt., II Abt., 10, 1902, 337) Putrefying meat.

Micrococcus chlorinus Cohn. (Grüngelber Coccus, Maschek, Jahresbor. d. Kom.- Oberrealschule zu Leitmeritz, 1887, 66; Cohn, Beitr. z Biol d. Pflanzen, 1, Heft 2, 1872, 155) From water and dust. Hucker (loc. cit., 10) considers this a synonym of Micrococcus conglomeratus Migula.

Micrococcus chromidrogenus citreu Trommsdorff. (Munch. Med. Wochnschr., 1901, No. 29, 1286; Abst. in Cent. f. Bakt., I Abt., Ref., 37, 1905, 60) Isolated from a case of chromidrosis of the axilla.

Micrococcus chromidrogenus ruber Trommsdorff (loc. cit.). Isolated from a case of chromidrosis of the axilla

Micrococcus chromoflavus Huss. (Cent. f. Bakt., II Abt., 19, 1907, 520) From cheese

Micrococcus chryseus Frankland and Frankland. (Phil. Trans. Roy. Soc. London, 178, B, 1888, 268.) From dust. Winslow and Winslow (loc. cit., 184) state that this species is apparently a synonym of Micrococcus aureus Zopf.

Micrococcus cinnabarinus Zimmermann. (Die Bakt. unserer Trink- u. Nutzwasser, Chemnitz, I Reihe, 1890, 76.) From water. Hucker (loc. cit, 26) regards this species as identical with Micrococcus cinnabareus Flugge.

Micrococcus cirrhiformis Migula (Ranken Coccus, Maschek, Jahresber d. Kom.- Oberrealschule in Leitments, 1887, 66; Migula, Syst. d. Bakt., 2, 190, 53) From water. Hucker (loc. cit, 22) considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidermidis Hucker.

Micrococcus citreus I and II, Maggiora (Giorn. Soc. Ital. d'Igiene, II., 1889, 35<sup>th</sup>. Abst. in Cent. f. Bakt., 8, 1890, 13, not Micrococcus citreus Eisenberg, Balt Ding, 3 Aufl., 1891, 36, not Micrococcus citreus Migula, Syst. d. Bakt., 2, 1900, 147; not Micrococcus citreus Winslow Mynslow, Systematic Relationships of the Coccaceae, 1908, 218.) From the normal skin of the foot.

Micrococcus citreus granulatus Frend. (Inaug. Diss., Erlangen, 1893, 27; Abst. in Cent. f. Bakt., 16, 1894, 641, Micrococus granulatus Bazarewski, Cent f Bakt., II Abt., 16, 1905, 7; not Micrococus granulatus Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 197.) From the oral cavity. Hucker (loc. cit., 9) regards this as a synonym of Micrococcus flamus Trevisan.

Micrococcus citreus lactis Conn. (Storrs Agr. Exp. Sta 12th Ann. Rept, 1900, 40.) From milk. Hucker (loc. cit., 10) considers this a synonym of Micrococcus conolomeratus Micula.

Micrococcus citreus rigensis Bazarenski. (Cent. f. Bakt., II Abt., 15, 1905, 5) From dust.

Micrococcus citrinus Migula. (Diplococcus citreus liquifaciens Unan and Tommasoli, Monats. f. prakt Dermatologie, 9, 1889, 56; Migula, Syst. d. Bakt, 2, 1900, 150; Micrococcus tommatoli Chester, Man. Determ. Bact, 1901, 101; Micrococcus citreus liquifaciens Winslow and Winslow, Systematic Relationships of the Coccaccae, 1908, 216) From human skin in a case of eczema. Winslow and Winslow (Ge. cit., 216) consider this a synonym of Micrococcus flavus Trevi-

Micrococcus claviformis von Besser. (Beitr. z. path. Anat. u z. allgem. Path., 6, 1889, 340; see Cent. f. Bakt., 7, 1890, 152.) Found once in masal secretions

Micrococcus Coccineus Migula. (Micrococcus No. VI, Adametz, Landwirtsch-Jahrb., 18, 1850, 212; Migula, 5yst. d. Bakt. 2, 1900, 174.) From Emmenthal cheese. Hueker (loc. cit., 20) regards this species identical with Micrococcus cinnabatrus. Filogre.

Micrococcus oils brevs Lehmann. (Lehmann, Inaug. Diss, München, 1903; Abst. in Cent f. Bakt., I Abt., Ref., 30, 1905, 688.) From feces of infants.

Micrococcus communis lactis Conn. (Starrs Agr. Lvp Sta. 12th Ann. Rept., 1900, 48.) From milk. Hucker (loc cit, 19) considers this a synonym of Micrococcus freudanteichis Guillebeau or of Micrococcus ureas Cohu

Micrococcus commensalis (Turró) Migula (Diplococcus commensalis Turró, Cent. f. Bakt., 16, 1891, 1; Migula, Syst. d. Bakt., 2, 1900, 125.) From sputum. Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus commutatus De Toni and Trevisan. (Alicrococcus albus I or Micrococcus albus fluidifeans Maggiora, Giorn Soc. Ital. d'Igrene, 11, 1889, 350; De Toni and Trevisan, in Saccardo, Svillere Funorum, 8, 1889, 1079.)

Micrococcus concentricus Zimmermann.
(Die Bakt. unserer Trink- u. Nutzwässer, Chemnitz, I Reihe, 1890, 86.)
From water. Winslow and Winslow
(loc. cit., 221) state that this is apparently a synonym of Micrococcus candicans
Flugge.

Mercocceus confuens Kern. (Arb. bakt Inst Karlsruhe, 1, Heft 4, 1897, 494) From the stomach and intestine of the starling (Sturnus vulgaris) and the finch (Fringella cardudis). Winstow and Winslow (loc. cit., 216) consider that a synonym of Micrococcus farus Trevisan.

Micrococcus conjunctivae Migula. (Micrococcus liquidactions conjunctivae Gombert, Recherches evpérimentales sur les microbes des conjunctives, Montpellier and Paris, 1859, Migula, Syst. d. Bakt., \$, 1900, 115) From normal human conjunctiva. Hucker (loc er., 15) considers this a synonym of Micrococcus albus Schmeter.

Micrococcus conjunctividis Migula. (Micrococcus fosus conjunctione Combert, Recherches expérimentales sur les microbes des conjunctives, Montpelher and Paris, 1859, Migula, Syst d. Bak t. 2, 1900, 141) From normal human conjunctiva. Winslow and Winslow (e.e.t., 216) consider this a synonym of Micrococcus facus Trevian, while Hucker (foe cit, 11) regards it as a synonym of Micrococcus citerus Migula

Micrococcus conoideus Migula. (Slaphylococcus salirarius pyogenes Blondi, Zischi i Hyg., 2, 1857, 227, Staphylococus sialopyus Trevisan, I generi e le snecie delle Batteriacce. Milan. 1859. 32; Micrococcus salivarius pyogenes Freire, Mémoire sur la hactériologie, pathogénie, traitement et prophylaxie de la fievre jaune. Rio de Janiero, 1898; Abst. in Cent. f. Bakt., I Abr., 26, 1899, 741; Staphylococcus pyogenes salivarius, quoted from Goadby, Trans. of Odontolog. Society, June, 1899, see Abst. in Cent. f. Bakt., I Abt., Ref., 31, 1902, 493, Migula, Syst. d Bakt., 2, 1900, 102.) From saliva Hucker (loc. cit., 12 and 15) regards this as a synonym of Micrococcus aureus Zopi or oi Micrococcus auteus Capitalia.

Micrococcus coralinus Cantani. (Cantani, Cent. f. Bakt., I Abt., 25, 1895, 311; Rhodococcus coralinus (sic) Levine and Soppeland, Iowa State Coll. Engineering Exp Sta Bul. 77, 1926, 22.) From dust. Hucker (loc. cit., 25) consuders this a synonym of Micrococcus roseus Flugge. Levine and Soppeland (loc. cit.) regard this as a synonym of Modococcus fulvus Winslow and Rogers. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 253.

Mtcrococcus coralloides Zimmermann.
(Die Bakt unserre Trink-u. Nutzwässer,
Chemnitz, II Reihe, 1891, 72) From
water. Winslow and Winslow (loc. cit.,
190) state that this species appears to be
a synonym of Mtcrococcus albus Zopf;
while Hucker (loc. cit., 17) considers it a
synonym of Micrococcus cascolyticus
Evans.

Micrococcus corrugatus Migula. (Merismopedia mesentericus corrugatus Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 355; Migula, Syst. d. Bakt., 2, 1900, 161.) From dust Winslow and Winslow (loc. cit., 216) consider thus a synonym of Micrococcus flavus Trovisan.

Mitrococcus coryate (Hajek) Migula. Otplococcus coryate Hajek, Berliner klin. Wochnschr., No. 33, 1888, Migula, Syst. d. Bakt., 2, 1900, 63.) From secretions in acute catarth. Winslow and Winslow (loc ett., 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffkya letragena Trevisan. Micrococcus cremoides Zimmermann (Die Bakt. unserer Trink- u. Nutzwasser, Chemnitz, I Reihe, 1890, 74.) From water. Winslow and Winslow (loc. cit.) 216) consider this a synonym of Micrococcus flavus Trevisan; while Hucker (loc. cit., 10) considers it a synonym of Micrococcus conflomeratus Migula.

Micrococcus cremoides albus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 350). From dust. Regarded by Dyar as a white form of Micrococcus cremoides Zimmermann.

Micrococcus cremoristicosi (Hammer and Cordes) Bergey et al. (Staphylococcus cremoris-viscosi Hammer and Cordes, Jour. Dairy Sci, 5, 1920, 291; Bergey et al., Manual, 3rd ed., 1930, 86.) From ropy milk. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 251.

Micrococcus crepusculum (Ehrenberg)
Cohn. (Monas crepusculum Ehrenberg,
Abhandl. d. Berliner Akad., 1830, 74 and
1832, 57; Cohn, Bertr. z. Biol. d. Pflanzen,
1, Heft 2, 1872, 100.) De Toni and Trevisan (in Saccardo, Sylloge Fungorum, 8,
1889, 1082) list the following as synonyms
of this species; Protococcus nebulosus
Kutzing, Linneae, 8, 1833, 365; Cryptococcus nebulosus Kutzing, Phycol. gener,
1845, 147, Cryptococcus natans Kutzing,
Spec. Alg., 1849, 146.

Micrococcus cretaceus Henrici. (Arb bakt. Inst Karlsruhe, I, Hett I, 1834, 65) From cheese. Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus cristatus Glage. (Ztschr. f. Fleisch- u. Mileh-hygiene, 10, 1900, 145.) From the surface of wurst and similar meat products.

Micrococcus cruciformis Freire. (Compt. rend. Acad. Sci., Paris, 128, 1899, 1047.) From the stamens and pistils of Hibiscus.

Micrococcus cumulatus Kern. (Arbbakt. Inst. Karlsruhe, 1, Heft 4, 1897, 497; not Micrococcus cumulatus Chester, see Micrococcus tenuissimus Migula.)
From the stomach and intestine of the yellow-hammer (Emberrae citinella) and of the finch (Fringella carduclis).
Hucker (loc. cit., 25) regards this as a synonym of Micrococcus tresus Fluere.

Micrococcus cupularis Migula (No 29, Lembke, Arch. f Hyg., 29, 1807, 331, Migula, Syst. d Bakt. 2, 1900, 211 From feces Winslow and Winslow (loc ett., 210) consider this a synonym of Micrococcus flows Travisan.

Micrococcus cupuliformis Migula. (No 19, Lembke, Arch f Hyg, 29, 1897, 325, Migula, Syst. d. Bakt. 2, 1900, 213) From feees. Winslow and Winslow (located 200) consider this a synonym of Micrococcus, M

Micrococcus curtusu Chorme (Chorine, Internat. Corn Borer Invest. Chicago, 2, 1923, 48) From diseased larvae of the corn borer (Pyrausta subilalis) Also virulent to larvae of the flour moti (Ephestia kühniella) and of the bee moth (Galletia mellonella)

Micrococcus cutts communis Sabournaud, (Sabournaud, Ann. A dermatol et syphil, 1896, Helt 3; Abst in Cent f Bakt, I Abt, 260, 1896, 291; Staphylococcus cutts communis Sabournaud, Practique Dermatologique, 1, 1903, 714.) From human shin expecially in alopeen a neerals, certain types of exerma and acne. May be the same as Micrococcus condermals Hucket.

Micrococcus eyaneus (Schroeter) Cohn (Bacteridum eyaneum Schroeter, Bestr z. Biol. d. Pilanten, 1, Heft 2, 1872, 122 and 120; Cohn, ibid. 150, Nigrococcus cyaneus Castellini and Chalmers, Man Trop. Med., 2nd ed., 1919, 932.) From dust and water

Micrococcus cyanogenus Pammel and Combs (Proc Iowa Yend Sci. 5, 1895, 136; see Abst in Cent f Bikt, II Abt, 2, 1896, 764). From milk

Micrococcus cyclops Henrici (Arb. bakt, Inst. Karlsruhe, 1, Helt 1, 1994, 69.) From Swiss cheese Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Micrococcus

Micrococcus cystiopoeus Muller-Thur gau. (Cent f. Bakt., II Abt., 20, 1908 464.) From pine

Micrococcus cytophagus Merker. (Cent f. Bakt., II Abt., 31, 1912, 589.) Found on the leaves of Elodea. Utilizes cellulose Stanier (Bact. Rev., 6, 1912 150) thinks that these micrococcus were microcysts of Sparceuloshagus ann

Micrococcus danteni Chester. (Coecus du rouge de morue, Le Dantec, Ann. Past. Inst., 5, 1831, 662; Chester, Man. Determ. Bact., 1901, 100) From red salted codishs. Hucker (loc. cit., 25) considers this a synonym of Micrococcus roseus Flower.

Micrococcus decalrens (Thin) Schrocter. (Bacterium decaltens Thin, Monats f prakt. Dermatol., No. 23, 1885; Schrocter in Cohn, Kryptog.-Flora v. Schlesien, 5, 1, 1856, 149.) From hair follieles in alonecia areata.

Micrococcus decipient Trevisan. (Bactérie de l'air, Cornil and Babes, Les Buctéries, 1885, 121; Trevisan, I generi e le specie delle Batterfacce, Milan, 1889, 34). From dust.

Micrococcus (Streptococcus ?) decolor Migula (No. 22, Lemble, Arch. f. Hyg., 26, 1896, 311; Migula, Syst. d. Bakt., 2, 1900, 203) From feces, Hucker (toc. cet., 17) considers this a synonym of Micrococcus cascolyticus Evans

Micrococcus deformans Grove. (Brit., Med Jours, Nov. 27, 1929, 815; Abet. in Cent f Bakt., I Abt., Ref., 73, 1922, 81) From cases of arthritis. A form of Micrococcus pyogenes albus according to Lebmann and Neutraann (Bakt. Ding., 7 Aufl. 2, 1927, 293).

Micrococcus delacourianus Rore. (Compt. rend. Acad. Sci., Paris, 123, 1896, 613 and 1323) From dry rotting potatoes.

Micrococcus dendroperties Ludwig. (Cent. f. Bakt., 10, 1891, 10.) From the bark of poplar teres (Populus ap.). Micrococcus denitrificans Beijerinek. (Cent. f. Bakt., II Abt., 25, 1910, 53.) From Rochelle salts (sodium potassium tartrate).

Micrococcus dermatogenes Fuhrmann. (Cent. f Bakt., II Abt., 17, 1906, 618.) 'From bottled beer.

Micrococcus diffuens Schroeter. (In Cohn, Kryptog.-Flora v. Schlesien, 8, 1, ISS6, 144.) From dust, feces, etc.

Micrococcus dimorphus Bucherer. (Planta, Archi f wissen. Bot., 1931, 98.) A dimorphic bacterium. He reports it as much like Micrococcus melitensis Bruce and Bacterium fraenkelii Hashimoto.

Micrococcus diphtericus (sic) Cohn (Micrococcus, Oertel, Deutsch. Arch 1. klin Med. 8, 1871; Cohn, Beitr. 2. Biol. d Pflanzen, 1, Heft 2, 1872, 162; Streptococcus diphtheriticus Zopf, Die Spaltpilze, 3 Aufl., 1885, 53) From throats and nasal passages of diphtheria patients

Micrococcus dissimilis Dyar. (See Sattler, Cent f Bakt, 5, 1899, 70; Dyar, Ann N Y. Acad Sci., 8, 1895, 353; Micrococcus trachomatis conjunctivae Sattler in Kral, Die gegennartigen Bestand der Kral'schen Sammlung von Mikroorganismen, 1900, 19) From trachoma infections. Hucker (loc ett., 17) considers this asynonym of Micrococcus cascolyticus Evans.

Micrococcus djokjakariensis Zettnow. (Cent. f. Bakt., I Abt., Orig , 75, 1915, 376.) From a sugar factory in Java. Micrococcus dovens De Toni and Trevi-

san. (Microeccus urnne albus olcarius Doyen, Jour. d connaiss. médic., No. 14, 1889, 108, De Toni and Trevisan, in Saceardo, Sylloge Fungorum, 8, 1889, 1076.) From urne Hucker (loc. cit., 16) states that this species is apparently identical with Microeccus albus Schroeter.

Micrococcus drimophylus Baumgartner. (Baumgartner, Drgebmisse d ges Zahnheilk., Heft 2, 1910, 729, Abst in Cent f. Bakt., I Abt., Ref., 48, 1911, 622.) From the mouth cavity Micrococcus catonii Corbet. (Quart. Jone. Rubber Rescarch Inst. Malaya, 2, 1930, 145.) From the latex of the rubber tree (Herca brasiliensis). For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 244.

Micrococcus churneus Henrici. (Atb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 881.) From Camembert cheese. Winslow and Winslow (loc. cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus ephestiae Mattes. (Sitzungsber. d. Gesellsch. z. Beförd. d. gesamt. Naturwissensch. zu Marburg. 62, 1927, 406 ) From the Mediterranean flour moth (Ephestia Luchniella).

Micrococcus epimetheus Corbet (loc. cit., 148). From the latev of the rubber tree (Herca brasiliensis). For a description of this species, see Bergey et al., Manual, 5th ed., 1930, 256.

Micrococcus esterificans Beck. (Arb. kaiser! Gesundheitsamte, 29, Heft 2, 1905, Abst. in Cent. f. Bakt., II Abt., 19, 1907, 591.) Has a characteristic frunty aroma From butter.

Micrococcus e czanthematicus Lewascheff. (Deutsch. med. Wochnschr. No-13 and 34, 1892; Abst. in Cent. f. Bakt. 12, 1892, 635.) From blood in cases of typhus fever. Motile. Grows anaerobically.

Micrococcus excavatus Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 187, 186.) From the stomach contents of a coot (Fulica atra) and a woodpecker (Picus major). Winslow and Winslow (loc. cit, 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus exiguus Kern (loc. cit, 470) From the stomach contents of the chafflinch (Fringella coelebs). Winslow and Winslow (loc. cit, 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit, 19) considers it a synonym of Micrococcus freudenreichii Guillebean or of Micrococcus under Cohn.

Micrococcus expositionis Chester. (No

34, Conn, Storrs Agr. Lvp Sta 7th Ann Rept., 1805, 77; Chester, Man Determ Bact, 1801, 92) From air Winslow and Winslow (loc. cit. 216) consider this a synonym of Micrococcus favus Trevisan; while Hueker (loc cit, 10) regards it as a synonym of Micrococcus conglomeratus Migula.

Micrococcus expressus Weiss. (Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 195.) From a carrot infusion. Produces slime. Hucker (loc. cit, 7) considers this species a synonym of Micrococcus luteus Cohn or of Micrococcus surians Micula.

Micrococcus faviformis Migula (Milchweisser Diplococcus, Bumm, Mikroorg. d. gonorth. Schleimbauthr, 11 Ausg., 1887, 18; Micrococcus lacteus faviformis Hugge, Die Mikroorgansmen, 2 Aufl., 1886, 182; Nesseria lactea Trevisan, I generi e le specie delle Batternace, Milan, 1889, 32; Migula, Syst d Bakt, 2, 1900, 117.) From vaginal and other body secretions. Winslow and Winslow (loc. ctt., 199) state that this appears to be a synonym of Micrococcus albus Schneter.

Micrococcus fedde Herter. (Micrococcus XVI, Choukevitch, Ann Inst Past., 23, 1911, 354; Botan. Jahresber, 29, II Abt., Heft 4, 1914, 755; Abst. in Cent. f. Bakt., II Abt., 51, 1920, 367) From the large intestine of a borse. Resembles Micrococcus rosendur Matzuschita.

Micrococcus fervitosus Adamets and Wichmann (Bakt. d Trink: u Nutzwässer, Mitt. Oest. Versuchstat f. Brauere u. Mälesren, Wien, Heft I, 1888) From water Winslow and Winslow (loc. ctt., 205) consider this a synonym of Gaffix at tragena Trevisan.

Micrococcus fickii Trevisan. (Coccus alministration and inquefaciens (Coccus candicans) Fick, Ueber Microorg. in Conjunctivalsack, Wiesbaden, 1887; Trovisan, I generi e le specie della Batteriacee, Milan, 1889, 33.) From conjunctiva

Micrococcus finlayensis Sternberg (Rept. on Etiology and Prevention of Yellow Fever, Washington, 1891, 219.) Obtained by Finlay in cultures front the liver and spleen of a yellow-fever cadaver. Hucker (loc. cit, 11) considers this a synonym of Micrococcus citreus Micula.

Micrococcus flaccidifez danai Brown (Amer Museum Novit., No. 251, 1927, 5) Causative agent of will disease of monarch butterfly larvae (Danais archippus) Considered a sub-species of Gyrococcus flaccidifez Glaser and Chapman (Science, 58, 1912, 219).

Micrococcus flagellatus Klotz (Jour. Med Research, 11 (NS6), 1904, 493.) Found in an epizootic among rabbits and white rats Supposedly flagellated.

Micrococcus flavens Henrici. (Arb bakt Inst Karlsruhe, 1, Heft 1, 1891, 80) From Swiss cheese Winslow and Winslow (loc. est, 216) consider this a synonym of Micrococcus flavus Trevisan

Micrococcus flaescens Henrici (Arb. bakt Inst Karlsruhe, I, Heft 1, 1894, 79) From Swiss cheese Winslow and Winslow (loc et 2, 26) consider this a synonym of Micrococcus flaesus Trevisan. For a description of this species, see Bergey et al, Manual, 5th ed., 1939, 246.

Micrococcus flavidus Henrici (loc. ct., 81; not Micrococcus flavidus Roze, Compt. rend Acad Sci., Paris, 122, 1896, 750) From Swiss and Limburger cheeses. Winslow and Winslow (loc. ct., 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus flavovirens Migula. (Staphylococcus viridis flavescens Guttmann, Arch 1. psth. Anat., 107, 1887, 201, Staphylococcus viridi-flavescens Trevisan, I. generi e le specie delle Batteriacce, Milan, 1889, 33; Migula, Syst. d. Baht., 2, 1900, 124; Micrococcus viridis-flavescens Winslow and Winslow, Systematic Relationships of the Cocaccae, 1906, 221.) Winslow and Winslow (find., 200) consider this a synonym of Micrococcus lates Cohn.

Micrococcus flavus non liquefaciens

Amsler. (Amsler, Korrespondenbl. f. Schweizer Aerzte, 1900, No. 9; Abst. in Cent. f. Bakt, I Abt., 29, 1901, 450.) From thermal springs.

Micrococcus fluorescens Maggiora. (Giorn Soc. Ital. d'Igiene, 11, 1889, 352; Abst. in Cent. f. Bakt., 8, 1890, 13.) From the skin of the foot.

Micrococcus foetidus Flugge. (Die Mikroorganismen, 2 Aufl., 1886, 172; not Micrococcus foetidus Veillon, Compt. rend. Soe Biol. Paris, 1893, 867; see Streptococcus foetidus Prévot.) From carious tecth.

Mtcrococcus foetidus Klamann. (Allgem. med. Centralzeitung, 1887, 1344.) Isolated from the posterior nares of man. Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schreeter.

Mtcrococcus fragilis (Dyar) Migula. (Merismopedia fragilis Dyar, Ann. N. Y. Acad Sci., 8, 1895, 351; Migula, Syst. d. Bakt., 2, 1900, 186) From dust. Hucker (loc. cit., 25) states that this species may be identical with Micrococcus roseus Flugge.

Micrococcus franklandiorum Trevisan. (Micrococcus candicans Frankland and Frankland, Phil Trans. Roy. Soc. London, 178, B, 1888, 270; not Micrococcus candicans Flugge, Die Mikroorganismen, 2 Aufl, 1886, 173; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 34.) From dust.

Micrococcus fulvus Weiss. (Arb. a bakt. Inst Karlsruhe, 2, Heft 3, 1902, 206; not Micrococcus fulvus Cohn, Beitr z. biol d Pflanz, 1, Heft 3, 1875, 181.) From a bean infusion.

Micrococcus fuscus Adametz. (Brauner Coccus, Maschek, Jahresh, d Kommunal-Oberrealsch zu Leitmentz, No. 6, 1867, 60; Adametz, Bakt. d. Nutz-u. Trinkwässer, Vienna, 1888, Micrococcus fuscus Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 932) Hucker (loccit., 10) states that this species is probably identical with Micrococcus conglomeratus Migula

Micrococcus galbanatus Zimmermana. (Bakt. unserer Trink- u. Nutwässer, Chemnitz, II Reihe, 1894, 68.) From water. Winslow and Winslow (loc. cit, 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus gallicidus Burrill. (Amer. Nat., 17, 1883, 320.) From blood of fowls infected with chicken cholera.

Micrococcus gelatinogenus Bräutigam. (Pharmaceutische Centralhalle, 32, 1891, 427.) From digitalis infusions See Micrococcus gummosus Happ.

Micrococcus gelatinosus Warrington. (The Lancet, 1, 1888, No. 25; Abst. in Cent. f. Bakt., 4, 1888, 394.) Curdles milk.

Micrococcus gelatinosus Issatchenko. Recherches sur les Microbes de l'Océan Glacial Arctique, Petrograd, 1914, 232; not Micrococcus gelatinosus Warrington, The Lancet, 1, 1888, No. 25.) From sca water.

Micrococcus giganteus lactis Conu (Storrs Agr. Exp. Sta. 12th Ann. Rept, 1900, 46.) From milk.

Micrococcus gigas Frankland and Frankland. (Philos. Trans. Roy. Soc., London, 178, B, 1888, 268.) From dust Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flagus Trevisan.

Micrococcus gilvus Losski. (Inaug. Diss., Dorpat, 1893, 60.) Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus Luteus Cohn.

Micrococcus gingirae Migula. (Micrococcus gingirae pyogenes Miller, Die Mikroorganismen d. Mundhöhle, Leipzig, 1889, 216; Migula, Syst. d. Bakt., 2, 1900, 68.) From alveolar pyorthoea, also from the mouth of a healthy man.

Micrococcus gingreardi Renault (Compt. rend. Acad. Sci., Paris, 120, 1895, 217.)

Micrococcus glandulosus Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 201.) From an asparagus infusion. Hucker (loc. cit., 19) regards this species as identical with Microscove froudenterehai Guillabout or with Micrococcus urene

Cohn

Micrococcus plohosus Kern (Arb. bakt, Inst. Karlsruhe, t. Heft 4, 1897. 469.) From the stomach contents of a coot (Fulica atra). Winslop and Winslow (loc. cit., 224) state that this is apparently a synanym of Micrococcus condicans

Micrococcus granulatus Weiss. (Arb bakt. Inst. Karlsruhe 2. Heft 3, 1902. 197.) From a malt infusion

Micrococcus granulosus Kern (loc. cst. 483). From the stomach contents of the vellow-hammer (Embersea cstrinella) and the starling (Sturnus vulgaris) Winslow and Winslow (loc. cit., 220) consider this a synonym of Merococcus luteus Cohn.

Micrococcus griseus (Warming) Winter (Baclerium griseum Warming, Videnskabelige Meddelelser fra den naturhist Forening i Klobenhavn, 1875, 398, Winter, in Rabenhorst, Kryptog -Flora v. Deutschl., Oesterr u d Schweiz, 2 Aufl., 1, 1884, 47

Micrococcus grossus Henrici bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 71.) From Camembert cheese Winslow and Winslow (loc cit, 221) state that this is apparently a synonym of Micrococcus candicans Flugge

Micrococcus gummosus Happ Inaug. Diss., Basel, 1893, 31, not Micrococcus gummosus Weiss, Arb bakt Inst Karlsruhe, 2, Heft 3, 1902, 189 ) From snakeroot and digitalis infusions Presumably Leuconostoc mesenteroides Van Tieghem.

Micrococcus haematodes Zopf. (Microbes de la sueur rouge, Babes, Biol Centralbi , 2, 1882, No 8; Zopf, Die Spaltpilze, 3 Aufl , 1885, 60.) The cause of red perspiration Hucker (loc. cit; 25) states that this may be a synonym of Micrococcus roseus Flugge.

Micrococcus haemorrhagicus (Klein) Migula, (Staphylococcus haemorrhagicus

Klein, Cent. f. Bakt., I Abt., 22, 1897. 81: Migula, Syst. d. Bakt., 2, 1900, 88.) Associated with an erythema of the skin resembling anthray Window and Wine. low flor cit 199) state that this appears to be a synonym of Micrococcus olbus Schrooter.

Micrococcus halensis Lohmann and Neumann (Macrococcus acidi maralactici liquefaciens balensis Kozai Ztechr f. Hye. \$1, 1899, 374; Lehmann and Neumann, Bakt, Diag., 2 Aufl., 2, 1899. 210. Micrococcus acida paralactici liquefaciens Thiele, Ztschr. f. Hvg., 46, 1904. 394.) From milk. Hucker (loc cet 17) considers this a synonym of Micrococcus caseoluticus Evans.

Micrococcus halophilus Bergev et al. (Culture No. 19. Baranik-Pikowsky, Cent. f Bakt., II Abt., 70, 1927, 373; Bergev et al., Manual, 3rd ed., 1930, 89 ) From sea water For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 258.

Micrococcus hauseri (Rosenthal) Mi-(Diplococcus hausers Rosenthal. Innug Diss., Berlin, 1893, 26; Migula, loc cit., 80 ) From the oral eavity. Winslow and Winslow (loc, cit., 224) state that this species is apparently identical with Micrococcus candicans Flugge.

Micrococcus helvolus Henrici (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1891. 77 ) From Swiss cheese. Winslow and Winslow (loc cit., 220) consider this to be identical with Micrococcus luteus

Micrococcus hibiscus Nahahama (Jour-Agr Chem. Soc. Japan, 16, 1940, 345, Eng Abs. Bull Agr. Chem Soc., 16. 1940, 51 ) Isolated from retting kenaf (Habiscus).

Micrococcus humidus Migula, (Micrococcus No 2, Adametz, Landwirtsch. Jahrb , 18, 1889, 239; Migula, Syst. d Bakt . 2. 1900, 50.) From Emmenthal cheese. Winslow and Winslow (loc. cit , 221) state that this species is apparently identical with Micrococcus candicans Flugge.

188; not Micrococcus minimus Bergey et al., Manual, 1st ed., 1023, 60.) From a bean infusion. Hucher (loc. cit., 7) considers this a synonym of either Micrococcus luteus Cohn or Micrococcus varians Migula.

Mecrococcus minutissimus Issatchenko. (Recherches sur les Microbes de l'Océan Glacial Artique, Petrograd, 1914, 146.) From sea water.

Micrococcus mirificus (Rabenhorst) Trevisan. (Palmella mirifica Rabenhorst, Hedwiga, 1867, 115, and Flor. Europ. Algar., 3, 1856, 35; Trevisan, Rendie R. Ist Lombardo, 12, 1879.)

Micrococcus mollis (Dyar) Migula. (Merismopedia mollis Dyar, Ann. N. Y. Acad. Sci, 8, 1895, 382; Migula, Syst. d. Bakt., 2, 1900, 161; Aurococcus mollis Winslow and Rogers, Science, 21, 1905, 699; Staphylococcus mollis Holland, Jour. Bact., 5, 1920, 225.) Trom air. A cause of boils in the tropics, according to Castellanı and Chalmers (Man. Trop. Med., 3rd ed., 1919, 931) Hucker (loc. cit., 12) states that this species is apparently identical with Micrococcus aureus Zopf.

Micrococcus (Diplococcus) morthuae Klebahn (Mitteil Inst Allgm. Botan. Hamburg, 4, 1919, 11-69; Abst. in Cent f. Bakt, II Abt, 52, 1921, 123.) Halophilic Associated with spoilage of salted fish.

Micrococcus mucilagineus Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1002, 191.) From bean infusions. Hucker (loc. cit., 11) states that this is probably a synonym of Micrococcus citreus Minula

Micrococcus mucliaginosus Migula. (Micrococcus der schleinigen Milch, Ratz, Arch. f Tierheilkunde, 12, Heft 1 and 2, 1890; Migula, Syst. d. Bakt., 2, 1900, 119; not Micrococcus mucliaginosus Weiss, Arb bakt Inst. Karlsruhe, 2, Heft 3, 1902, 205.) From slimy milk. Winslow and Winslow (loc. ct. 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Huecker (loc. cti. 18) considers it a syn-

onym in part of Micrococcus cascolyticus Evans.

Micrococcus mucofaciens Thöni and Thaysen. (Cent. f. Bakt., II Abt., 38, 1913, 359; not Microcaccus mucofaciens Pribram, Klassifikation der Schizomyceten, 1933, 42.) From milk. Huche (loc. cit., 9) considers this a synonym of Micrococcus flavus Trevisan. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 215.

Micrococcus myceticus Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928, 535-536.) From gummy lesions Micrococcus mycodermatus Holland.

(Jour. Bact., 5, 1920, 224.)

Micrococcus nacreaceus Migula. (Perlmutterglanzender Diplococcus, Tatsonf, Iraug. Diss., Dorpat, 1891, 70; Migula, Syst. d. Bakt., 2, 1000, 62.) Winslow and Winslow (foc. cit., 221) state that this is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus ncoformans Doyen. (Doyen, Le Micrococcus ncoformans et les néoplasmes, Paris, 1903.) From cancerous tissue. Shown by Andrewes and Gordon (35th Ann. Rept. Local Got Board, London, 1905-06, 553) to be identical with Micrococcus epidermidis albus Wolch.

Micrococcus neurotomae Paillot. (Compt. rend. Acad. Sci., Paris, 178, 1924, 246.) Gram-negative. From the larvae of Neurotoma nemoralis.

Micrococcus neuvillei Trevisan. (Micrococcus G, Malapert-Neuville, 1837; Trevisan, I generi e le specie delle Batterincee, Milan, 1889,34.) From mineral water.

Micrococcus nigrescens Castellani. (Brit. Jour. of Dermatology, 23, 1911, 341; Nigrococcus nigrescens Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 2103.) Produces a black pigment. Found in the black variety of trichomycosis avillaris, a tropical disease.

Micrococcus nigrofaciens Northrup. (Mich. Agr. Exp Sta. Tech. Bull. No 18, 1914, 12; also in Cent. f. Bakt., II Abt. 41, 1914, 326.) From diseased larvae of the June beetle (Lachnosterna sp.) and other insects.

Micrococcus nitidus Kern. (Arb bakt. Inst. Karlsrube, 1, Heft 4, 1897, 476 )
From the stomach and intestine of birds Winslow and Winslow (loc. ett., 199) state that this appears to be a synonym of Micrococcus albus Schroeter, while Hucker (loc. cit., 19) regards it as a synonym of Micrococcus freudenreichts Guillebeau or al Micrococcus greudenreichts Guillebeau or al Micrococcus greudenreichts Guillebeau or al Micrococcus greudenreichts Guillebeau or al Micrococcus greudenreichts

Micrococcus nitrificans Bergey et al (Micrococcus 6, Rubentschek, Cent f Bakt, II Abt, 72, 1927, 125, Bergey et al, Manual, 3rd ed., 1930, 88, not Micrococcus nitrificans van Tieghem, Traité de Botanique, Paris, 1883 ) From sewage filter beds. For a description of this species, see Bergey et al., Manual, 5th ed. 1930, 255.

Micrococcus nuralis Chester. (No 47, Conn, Storrs Agr. Evp. Sta. 7th Ann Rept., 1895, 80, Chester, Man Determ Bact., 1901, 90.) From dust. Winslow and Winslow (loc. ett., 224) state that this is apparently a synonym of Micrococcus candicans Flüre.

Micrococcus nircus Henrie (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 66.) From Swiss cheese. Winslow and Winslow (loc. cit, 221) state that this is apparently a synonym of Micrococcus candicans Fliere.

Micrococcus nonfermentans Steinhaus (Jour. Bact., 42, 1941, 779) From the alimentary tract of the lyreman cicada (Tibicen linnei) and of an unidentified damsel fly (Coengarionidae)

Micrococcus multis Migula (Coccus II, Toutin, Bakt Untersuch von Hagel.) Wratsch, No. 49 and 50, 1889, see Cent. I. Bakt, 7, 1890, 373, Migula, Syst d Bakt, 2, 1900, 013, Micrococcus beta Chester, Man. Determ Bact, 1901, 87.) Isolated from hait. Winslow and Winslow (Rec. cit., 205) consider this to be a synonym of Micrococcus candidus Cohn or of Gofflya tetrogram Trevism.

Micrococcus nuclei Roze (Compt

rend. Acad. Sci., Paris, 122, 1896, 544.) From potatoes.

Micrococcus obscoenus Kern (Arb., bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 473.) From the stomach contents of a crow (Coreus corone). Winslow and Winslow (Ice. cit., 190) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (Ice. cit., 191) considers it a synonym of Micrococcus freudenreicht: Guillebeau or of Micrococcus ureas Cohn

Micrococcus achracus Rosenthal. (Inaug. Diss., Erlangen, 1803, 22; Abst. in
Cent f. Bakt., 16, 1891, 1024; not Micrococcus ochracus Hansgurg, Oestr. Bot.
Ztschr, 1885, No. 4) From the ornl
cavity Winslow and Winslow (loc. cit.,
220) consider this a synonym of Micrococcus luteus Migula. For a description
of this species see Bergey et al , Manual,
5th ed., 1999, 212.

Micrococcus ochroleucus Prove. (Prove, Beitr z Biol d Pflanz 4, Heft 3, 1887, 409, Streptococcus ochroleucus Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 31, Planococcus ochroleucus Migula, Syst d Bakt, 2, 1909, 272) From urine. Motile

Micrococcus odoratus Henriei. (Arb. bakt Inst Karlsruhe, 1, Heft 1, 1894, 73) From cheese Winslow and Winslow (loc cit, 224) state that this is apparently a synonym of Micrococcus candicans Flaces.

Micrococcus odorus Henrici (loc cit., 72) From cheese Winslow and Winslow (loc cit., 221) state that this species is apparently a synonym of Micrococcus candicans Flügge

Merococcus oleanus De Ton and Trevisus (Micrococcus urinar flavis oleanus Doyen, Jour di commass Midir. No. 14, 1889, 108, De Tom and Trevisus, in Saccardo, 83 floge Funoroum, 6, 1889, 1077.) From urine Hucker (loc. etc., 12) considers this species a synonym of Micrococcus autrus Zopl

Micrococcus olens Henrier (Arb. bakt Inst. Karlsrube, 1, Heft 1, 1891, 87.) From Swiss cheese. Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus opalescens De'Toni and Trevisan. (Micrococcus albus II, Maggiora, Giorn. Soc. Ital. d'Igiene, II, 1839, 351; De'Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1078.)

Micrococcus orbicularis Chester. (Micrococcus orbicularis flavus Ravenel, Mem. Nat. Acad. Sci., 6, 1896, 8; Chester, Man Determ. Baet., 1901, 101.) From soil Winslow and Winslow (Ico. cit., 216) consider this a synonym of Micrococcus flavus Trevisan; while Hucker (Ico. cit., 10) regards it as a synonym of Micrococcus conglomeratus Migula.

Micrococcus orbiculatus Wright. (Mem. Nat. Acad Sci., 7, 1895, 432.) From Schuyll.ill River water. Winslow and Winslow (loc cit, 220) consider this a synonym of Micrococcus Indeus Cohn.

a synonym of Micrococcus Iuleus Cohn.
Micrococcus ovalis Kern. (Arb. bakt.
Inst. Karlsruhe, I, Heft 4, 1897, 500;
not Micrococcus ovalis Escherich, Die
Darmbakterien des Sauglings, Stuttgart,
1886, 90 ) From the stomach contents
of the rock dove (Columba Iuria).
Hucker (loc. cit. 9) regards this as a
synonym of Micrococcus fausus Trevisan.

Micrococcus pallens Henrici. (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1894, 61.) From cheese. Winslow and Winslow (loc cit, 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus pallidus Henrici (loc cit., 62) From cheese Hucker (loc. cit., 7) regards this species as identical with either Micrococcus luteus Cohn or Micrococcus varians Migula.

Micrococcus pannosus Kern. (Arb. hakt. Inst. Karlsruhe, 1, Heft 4, 1897, 466.) From the stomach contents of the rock dove (Columba lucia) and the intestine of another dove (Columba cenas). Winslow and Winslow (loc cit., 221) state that this is apparently a synonym of Micrococcus candicans Flügge.

Micrococcus paraffinae Söhngen.

(Cent. f. Bakt., II Abt , 57, 1913, 595.) From garden earth.

Micrococcus parotitidis Korentschensky. (Cent. f. Bakt., I Abt., Orig, 41, 1907, 402.) Isolated from cases of parotitis epidemica.

Micrococcus parvus (Miller) Trevisan (Jodococcus parvus Miller, Deutsche med. Wchnschr., No. 30, 1883; Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33)

Micrococcus parsus Migula. (No 14, Lembke, Arch. f. Hyg., 26, 1896, 309), Migula, Syst. d. Bakt., 2, 1900, 200) From feces. Winslow and Winslow (lac cit., 224) state that this species is apparently a synonym of Micrococcus candicans Flucre.

Micrococcus pasteuri Trevisan. (Alicrobe pyogene de l'eau de Seine, Pasteur, 1877; Trevisan, I generi e le specie delle Batteriacce, Alilan, 1889, 34; not Micrococcus pasteuri Sternberg, Trans. Pathol Soc. of Philadelphia, 12, 1885, 162.) From water.

Micrococcus pellucidus Kern. (Atb. bakt. Inst. Karlsruhe, 1, Helt 4, 1837, 485; not Micrococcus pellucidus Roze, Compt. rend. Acad. Sci., Paris, 122, 1896, 1012.) From the intestine of asparrow [Passer montanus). Hucker (loc.cit., 23) regards this as a synonym of Micrococcus candidus Cohn or of Micrococcus evidermidis Hucker.

Micrococcus pemphigi Migula. (Diplococcus des Pemphigus acutus, Demme, Verhandl. d. Kongr. f. innere Med., Wiesbaden, 1886, 336; Diplococcus pemphigi acuti Lehmann and Neuman, Bakt. Diag., I Aufl., 2, 1806, 173; Migula, Syst. d. Bakt., 2, 1900, V. and 191; Micrococcus demme: Chester, Man Determ. Bact., 1901, 74.) Isolated from bullae in a case of pemphigus acutus.

Micrococcus pemphigicontagiosi Castellani and Chalmers. (Micrococcus pemphigi contagoosa Clega and Wherry, Jour-Inf. Dis., 8, 1906, 171; Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 931.) From bulka in a case of pemphigus contagiosa. This may be a synonym of Micrococcus pemphigineonatorum, see below.

Microoccus pemphaganconatorum Castellani and Chalmers. (Microoccus pemphagi neonatorum Almquast, Zischr I. Ilyr., 10, 1891, 253, Staphylococcus pemphagi neonatorum Ichmann and Neu mann, Bakt. Drag., 1 Autil. 2, 1896, 173, Castellani and Chalmers, Mun Trop Med., 3rd ed., 1919, 971.) Found in bulke in a case of pemphagas neonatorum This may be Microoccus molits, according to Castellani and Chalmers (loc etc.) Talls (Jour. Inf. Drs. 2, 20, 1977, 57) identifies this and the previous organism as Microoccus progens are accused.

Vicrococcus perciteus Bergey et al. (Manual, 1st ed., 1921, 63) From au and water. Hucker (loc est., 10) considers this a synonym of Micrococcus conflomeratus Migula. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 218.

Micrococcus perfarus Berge, et al. (Manual, 1st ed., 1923, 62) I From air and water. Hucker (loc. cit, 12) regards this as a synonym of Micrococcus aureus Zopl. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 217.

Micrococcus persicus Kern (Arb bakt. Inst. Karlsruhe, 1, Helt 1, 1897, 199) From the intestine of a dove (Columba ocnas). Hucker (loc cit, 25) states that this may be identical with Micrococcus roseus Flugge.

Micrococcus petechialis Trevisan (Micrococco del dermotifo, Bareggi, 1886, Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33)

Micrococcus petilus Trevisin. (Micrococcus der Pyaemie bei Kaninchen, Koch, Über d. Actiolog, d. Wundinfectionskr., Leipzig, 1878; Micrococcus pyaemiae cuniculorum Schrocter, in Cohn, Kryptogam. Flora v. Schlessen, 3, 1, 1886, 148, Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 33, 34/irrococcus cuniculorum Migula, Syst. d. Bakt., 2, 1900, 192) From rabbits.

Micrococcus petroles Renault. (Compt.

from Clattenden, U. S. Dept. Agr., Farmers' Bull No 1661, 1926, 6) From larvae of the cabbage butterfly (Pieris range).

Micrococcus pilouskyi Bergey et al. (Catture No. 22, Barmik. Pikowsky, Cent. f. Bakt. II Abt., 70, 1927, 373; Bergey et al., Manual, 3rd of, 1930, 78.) From sea water. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 212.

Micrococcus piliformis Weiss. (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902) 191) From a beni infusion. Hucker (loc cit., 7) considers this a synonym of Micrococcus luteus Cohn or of Micrococcus cuttarians Migula

Micrococcus pillonensis Gray and Thornton. (Cent f Bakt, II Abt, 73, 1923, 81) From manure and soil For a description of this species, see Bergey et al, Manual, 5th ed, 1939, 259

Micrococcus pitutoporus (Hohl) Buchana and Hammer. (Karphococcus) pitutoporus Hohl, Jahrb. d Schweiz, 22, 1903, 439, Diplococcus praesous Sato, Cent. f. Bakt, II Abt., 19, 1907, 27; Buchanan and Hammer, Iowa Agr. F. Fry Sta. Res. Bull 22, 1915, 285). From slimy milk and from straw. Hucker (loc ett., 23) states that this species is probably identical with Micrococcus conduius Colin or with Micrococcus epiderandis Hucker. For a description of this species, see Bergey et al, Manual, 5th ed, 1939, 233

Micrococcus plumosus Eisenberg. (Brautigam, Inaug. Diss, Leipzig, 1886, 18; Federiger Micrococcus, Adametz, Mitteli. d Oesterr Versuchssta f Brauerei u Mälterei, Vien, 1161 f. 1885; Eisenberg, Bakt. Ding, 3 Aufl, 1891, 55.) From Ieces of cattle and from water. Winslow and Winslow (doc. ct.)

220) consider this a synonym of Micrococcus luteus Cohn; while Hucker (loc. cit., 22 and 23) regards it as probably identical with Micrococcus candidus Cohn or Micrococcus epidermidis Hucker.

Micrococcus polypus Migula. (Syst. Bakt , 2, 1900, 79.) From air. Hucker (loc. cit., 23) states that this species is probably identical with Micrococcus candidus Colin or Micrococcus enidermidis Hucker.

Micrococcus populi Delacroix. (Bul-Mens. Off. Renseig Agr., Paris, 5, 1906, 1349 and Ann. Inst. Nat. Agron., 2 Ser., 5, 1906, 353.) Parasitic on poplar trees (Populus spp ).

Macrococcus vorcellorum Trevisan. (Micrococcus bei Hepatitis enzootica porcellorum, Nonewitsch, Cent. f. Bakt., 3. 1888, 233, Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 33 ) From an infected liver.

Мистососсия progrediens Schroeter (Mierococcus der progressiven Abscessbildung ber Kaninchen, Koch, Über d Actiolog. d. Wundinfectionskrankheiten, Leipzig, 1878; Schroeter, in Cohn, Kryptogam Flora v. Schlesien, 5, 1, 1896, 148; Micrococcus haemalosaprus Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 33.) From the blood of diseased rabbits.

Micrococcus psalteri Buemann f. Bakt , I Abt., Orig , 71, 1913, 308 ) From the third stomach of cattle

Micrococcus pseudocyaneus Schroeter. (Kryptogam - Flora v. Schlesien, 3, 1, 1886, 145 ) A synonym of Micrococcus evaneus Cohn according to Migula, Syst.

d. Bakt., 2, 1900, 188.

Micrococcus pseudoinfluenzae Migula. (Microorganismus I, Fischel, Ztschr. f Heilkunde, 12, 1891; See Cent. f. Bakt., g. 1891, 611; Migula, Syst d. Bakt , 2, 1900, 86 ) From the blood of an influenza patient, Hucker (loc cit., 23) considers this a synonym of Micrococcus candidus Cohn or of Micrococcus epidermidis Hucker

Micrococcus pulcher Glage (Ztschr

f. Fleisch- u. Milchhyg., 10, 1900, 146; not Micrococcus pulcher Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 182) From coating on surface of wurst and similar meat products.

Micrococcus pultiformis Kern. (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 474.) From stomach contents of the vellow-hammer (Emberiza citrinella) and starling (Sturnus vulgaris) and from the intestine of the woodnecker (Picus maior). Winslow and Winslow (loc. cil., 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit., 19) regards it ss probably identical with Micrococcus freudenreichii Guillebeau or with Micrococcus ureae Cohn.

Micrococcus punctatus Migula. (No. 18, Lembke, Arch. f. Hvg., 29, 1897, 325, Migula, Syst. d. Bakt., 2, 1900, 213) From feces. Winslow and Winslow (loc cit., 199) state that this species appears to be a synonym of Micrococcus albus Schroeter

Micrococcus purpurifaciens Lehmann (Micrococcus, Dudtand Neumann schenko, Cent. f. Bakt., H Abt., 42, 1915, 529; Lehmann and Neumann, Bakt Diag , 6 Aufl., 2, 1920, 755.) From ice Produces a purple pigment in alkaline gelatin media.

Henneberg. pusiulatus Micrococcus (Cent. f. Bakt., II Abt., 55, 1922, 251.) From the human intestine.

Tilanus putridus Micrococcus (Munch med. Wchnschr., 54, 1887, 310) From gelatin, agar, etc., containing iodiform.

Micrococcus pygmacus Henneberg (los cit., 252) From the human intestine. pyocyaneus Francisco Micrococcus (Revista Valenciana de Ciencias Médicas, 1914, 2, Abst in Cent. f. Bakt., I Abt, Ref., 63, 1915, 44; not Micrococcus pyocyaneus Gessard, Thesis, Paris, 1882)

Micrococcus pyosepticus (Héricourtand Richet) Solowjew (Staphylococcus pyosepticus Héricourt and Richet, Compt

From an acne pustule.

rend. Acad. Sci., Paris. 107, 1888, 601; Solowiew, Abst. in Cent. f. Bakt. I Abt., 18, 1895, CO.) I'rom an abscess in a dog and from dust. Regarded as identical with Micrococcus albus Schroeter

Micrococcus augdrigeminus Klebs. (Staphylococcus quadrigeminus Vanselow and Czaplewski, Cent. f. Bakt., I Abt . 25, 1890, 113; see Lehmann and Neumann. Bakt. Diag., 2 Aufl., 2, 1899, 174) Closely related to Micrococcus albus Schroeter.

Micrococcus quaternus Migula (Sicbert, Inaug. Disa, Würzburg, No. I, 1591, 7; Migula, Syst. d. Bakt., 2, 1900. 92 ) Winslow and Winslow (loc cit. 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus radiatus Plugge, (Die Mikroorganismen, 2 Aufl., 1886, 176; Streptoroccus radigius Crookshank, Man of Bact., 3rd ed , 1890, 256; not Mierococcus radiatus Kern, see below ) From dust and water. Winslow and Wenslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit , 18) considers it a synonym of Micrococcus easeolyticus Evans.

Micrococcus radiolus Kern, (Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1807, 471; Micrococcus radiosus Migula, Syst. d. Bakt., 2, 1900, 114 ) From the stomach contents of the starting (Sturnus vulgaris). Winslow and Wanslow (loc cit, 199) state that this appears to be a synonym of Micrococcus albus Schroeter

Micrococcus тесязы Rosenthal (Inaug. Diss., Berlin, 1893, 19; Abst in Cent f. Bakt., 18, 1891, 1021.) From the oral cavity. Winslow and Winslow (loc. cit , 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Mucrococcus regularis Weiss. (Arb. bakt Inst Karlsruhe, 2, Heft 3, 1902, 183.) From bean infusions. Hucker (loc cit, 7) considers this a synonym of Macrococcus luteus Cohn or Micrococcus varians Mıgula.

Micrococcus resinaceus Kern, (Arb. bakt, Inst. Karlsruhe, 1, Heft 4, 1897. 487.) From the stomach contents of the starling (Sturnus vulgaris) and from the intestine of a sparrow (Passer montanus). Winslow and Winslow (loc. cit., 220) regard this as a synonym of Micrococcus Intens Cohn

Micrococcus rhenanus Migula. (Neuer Mikromecus aus Rheinwasser, Burri, Arch. f. Hyg., 19, 1893, 31; Migula, Syst. d. Bakt., 2, 1900, 109; Micrococcus rheni Chester, Man. Determ. Bact., 1901, 82; Albococcus rhenanus Winslow and Rogers. Jour. Inf. Dis., 5, 1906, 511.) I'roni Rhine River water. Winslow and Winslow (loc cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter: while Hucker (loc. cit., 18) considers it a synonym of Micrococcus caseolutious Evans.

Micrococcus ridlevi Corbet, (Quart. Jour. Rubber Research Inst., Malaya, 2, 1930, 146.) From the later of the rubber tree (Herca brasiliensis). For a description of this species, see Bergey et al . Manual, 5th ed., 1939, 211,

Micrococcus rosaceus Prankland and Frankland. (Trans. Roy Society, London, 178, B, 188, 269; Rhodococcus rosaceus Holland, Jour. Bact , 5, 1920, 225 ) From air Hucker (loc cit., 25) states that this species may be identical with Micrococcus roseus Flügge. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 252

Micrococcus rosaceus lactis Conn. (Storrs Agr. Exp. Sta 12th Ann Rept., 1900, 34; Micrococcus lactis rosaccus Conn. Esten and Stocking, Storrs Agr. Exp Sta. Rept. for 1906, 108.) From milk.

Micrococcus roscidus Migula. (Micrococcus No I. Adametz, Landwirtsch. Jahrb., 18, 1889, 238; Migula, Syst. d. Bakt . 2, 1900, 68 ) From Emmenthal cheese. Winslow and Winslow (loc. cit., 224) state that this is apparently a synonym of Microccccus candicans Flügge.

Micrococcus roseo-persicinus Migula.

(Rote Kokken von Van Ermengem, Schneider, Arb. bakt. Inst. Karlsruhe, 1, Heft 2, 1894, 216; Migula, Syst. d. Bakt., 2, 1900, 184)

Micrococcus rosetlaceus Zimmermann.
(Bakt. unserer Trink- u. Nutzwässer,
Chemnitz, I. Reihe, IS90, 72.) From
water. Winslow and Winslow (loc. cit.,
224) state that this is apparently a
synonym of Micrococcus candicans
Flurce.

Mucrococcus roseus Maggiora (Giorn. Soc. Ital. d'Igiene, 11, 1889, 356; not Micrococcus roseus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 183; not Micrococcus roseus Gruber, Cent. f. Bakt., II Abt., 28, 1909, 408)

Micrococcus rubellus Migula. (Syst. d. Bakt, 2, 1900, 169) Source not given. Hucker (loc. cit, 27) regards this as identical with Micrococcus cinnabareus Flugge.

Micrococcus rubescens Migula. (No. 20, Lembke, Arch. f Hyg, 20, 1896, 312; Migula, Syst d Bakt, 2, 1900, 208; not Micrococcus rubescens Chester, see Micrococcus subroscus below) From feces. Hucker (loc cit., 27) regards this species as identical with Micrococcus cinnabareus Flugge.

Micrococcus rubidus lactis Conn (Conn, Storrs Agr Exp Sts 12th Ann. Rept., 1900, 34, Micrococcus lactis rubidus Conn, Esten and Stocking, Storrs Agr. Exp Sta 18th Ann Rept., 1907, 117.) From milk. Resembles Micrococcus cinnabareus Flugge Hucker (loc. cul., 25) thinks this species may be identical with Micrococcus roseus Flugge.

Micrococcus rubigenosus Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 492.) From the stomach contents of a dove (Columba coras). Hucker (loc. ct., 25) ,tates that this species may be identical with Micrococcus roseus Flugge.

Microcolcus rubiginosus Passer. and Beltr. (Fung Sicil., 18—, no 35, quoted from De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1082)

Micrococc us rugatus Migula (Micro-

coccus endocarditidis rugatus Weichselbaum, Beitr. z. path. Anat. u. z. alga. Pathol., 4, 1889, 164; Migula, Syst. d Bakt., 2, 1900, 190; Micrococcus endocardits Chester, Man. Determ. Bat. 1901, 74.) From ulcerative endocardits. Winslow and Winslow (loc. cit., 205) consider this a synonym of Micrococcus cendidus Cohn or of Gaffkya tetragena Trevisan; while Hucker (loc. cit., 15) regards it as a synonym of Micrococcus albus Schroeter.

Micrococcus rugosus Chester. (No. 2, Conn, Storrs Agr. Exp. Sta. 6th Aan Rept., 1894, 50; Chester, Man. Determ. Bact., 1901, 101.) From milk and ripened cream. Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan.

Micrococcus ruminantium Henneberg. (Cent. f. Bakt., II Abt., 55, 1922, 252) From the human intestine.

Micrococcus rushmorei Brown. (Amer. Museum Novit., No. 251, 1927, 4.) Isolated from a fly (Lucilia sericala) which was infected with Bacillus lutae.

Micrococcus saccatus Migula. (Micrococcus albus liquefaciens von Besset, Beitr. z. path. Anat., 6, 1889, 46; Micrococcus liquefaciens albus, sec Cent. f. Bakt , 7, 1890, 152; Migula, Syst. d Bakt., 2, 1900, 117; Micrococcus lique. faciens Chester, Man. Determ Bact 1901, 78; not Micrococcus liquefaciens Holland, Jour. Bact., 5, 1920, 224; Mrcrococcus alv: Chester, loc. cit., 81.)From the nasal mucous membrane. Winslow and Winslow (loc. cit., 199) state that this is apparently a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit, 19) regards it as probably identical with Micrococcus freudenreichii Guillebeau or with Micrococcus ureae Cohn-For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 251.

Micrococcus salivalis septicus, quoted from Wigura, see Cent. f. Bakt., I Abt, 17, 1895, 899. From the human skin.

Micrococcus sarcinoides Migula. (Syst. d Bakt., 2, 1900, 168.) Hucker (loc. cit., 27) considers this identical with

Micrococcus scariosus Migula. (Sebert, Inaug Diss., Wurzburg, No. II, 1894, 9; Migula, Syst. d. Bakt., 2, 1900, 91.) From a hairbrush. Winslow and Winslow (Loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus scarlatmosus Trevisan. (Trevisan, Batteri Italiani, 1879, 19, Streptococcus rubiginosus Edington, Brit. Med. Jour. J., 1887, 1265, Perroncios scarlatmosa Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 20). From a scarlet feeter natient.

Micrococcus scarlatinus Migula (Syst. d. Bakt., 2, 1900, 173) From feces

Micrococcus selenicus Brenner (Jahrb f. wissensch. Botan, 67, 1916, 85, Abst in Cent. f. Rakt., II Abt., 48, 1918, 431) From mud

Micrococcus sensibilis Zettnow (Cent I. Bakt, I Abt., Orig., 77, 1915, 216.) From dust Hucher (loc. cit., 19) considers this a synonym of Micrococcus freudenrichii Guillebeau or of Micrococcus ureae Cohn. For a description of this species, see Bergey et al., Manual, 5th ed., 1830, 248.

Micrococcus septicus (Klebs) Cohn (Microsporon septicus Klebs, Die Ursachen der infectiosen Wundkrankheiten, 1871, and Zur path Anat. d Schusswunden, 1872; Cohn, Betr z Biol. d Pflanzen, 1, Heft 2, 1872, 164.) From pus

Micrococcus serophilus Costa. (Compt. rend. Soc. Biol., Paris, 83, 1920, 931) From acute articular rheumatism

Micrococcus serratus Migula (No. 15, Lembke, Arch f. Hyg. 26, 1893, 693) Migula, Syst d. Bakt, 2, 1900, 200.) From feces Winslow and Winslow (loc cit, 205) regard this as a synonym of Micrococcus candidus Cohn or of Gaffiya tetragena Trevisan.

Micrococcus sialosepticus Trevisan. (Coccus salwarius septicus Biondi, Ztschr f. Hyg., 2, 1887, 195; Coccus septicus Biondi, ibid., 220; Trovisan, I generi e le specie delle Batteriacee, Milan, 1889, 33; Micrococcus salivarus Migula, Syst. d. Bakt., 2, 1900, 65; Micrococcus salivarus-septicus Chester, Man. Determ. Bact., 1901, 87.) From human saliva. Winslow and Winslow (loc. cit., 205) consider this a synonym of Micrococcus candidus Cohn or of Gaffhya tetragena Trevisan.

Micrococcus siccus Miguls. (Micro-coccus No. V, Adamets, Iandwritsch. Jahrb., 18, 1889, 21; Migula, Syst. d. Bakt., 2, 1900, 124.) From Emmenthal cheese. Winslow and Winslow (loc. cit, 185) state that this is probably a synonym of Micrococcus aurantiacus Cohn, while Hucker (loc. cit., 7) consects it a synonym of Micrococcus luteus Cohn or of Micrococcus rations Migula.

Micrococcus similis Dyar. (Ann. N. Y. Acad Sci., 8, 1895, 347.) From dust. Winslow and Winslow (loc et., 205) regard this as a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan.

Micrococcus simplex Wright. (Mem. Nat. Acad. Sci., 7, 1895, 432.) From Schuylkill River water Winslow and Winslow (loc ett., 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus simulans DeToni and Trevisan. (Micrococcus citreus II, Maggiora, Giorn Soc Ital. d'Igiene, II, 1889, 351; DeToni and Trevisan, in Sacsardo, Sylloge Fungorum, 8, 1889, 1079.)

Micrococcus sordidus Schroeter (Schroeter in Colin, Kryptogam -Flora v Schlesien, 5, 1, 1886, 145) Winslow and Winslow (loc. cit, 224) state that this is apparently a synonym of Micrococcus candicans Plugge.

Micrococcus sphaeroides Gray and Thornton. (Cent. f Bakt, II Abt., 73, 1928, 74) From manure and soil Fro a description of this species, see Bergey et al., Manual, 5th ed., 1930, 259.

Micrococcus staphylophagus Serbinov.

(La Defense des Plantes, Leningrad, 2, 1926, 556; see Rev. Appl. Mycol., 5, 1926, 650 ) Considered pathogenic on grape-

vines.

Micrococcus stellatus (Lustig) Frankland and Frankland, (Stern-Coccus, Maschek, Jahresber, d. Kom, Oberrealschule, Leitmeritz, No. 10, 1887, 62; Coccus stellatus Lustig, Diag, d. Bakt, d. Wassers, 2 Aufl., 1893, 40; Frankland and Frankland, Micro-organisms in Water, 1894, 503 ) From water Winsolw and Winslow (loc cit, 220) regard this as a synonym of Micrococcus luteus Cohn.

Micrococcus strobiliformis Migula. (No. 23, Lembke, Arch f. Hyg., 26, 1896, 315; Migula, Syst. d. Bakt., 2, 1900, 203.) From feces Winslow and Winslow (loc. cit. 220) regard this as a synonym of

Micrococcus luteus Cohn.

Micrococcus subcandicans Lavanchy. (Univ. Genève, Inst. bot. Prof. Chodat. Sér 8, Fasc 12, 1914, 68, Abst in Cent. f. Bakt , II Abt , 47, 1917, 611.) From water of Lake Geneva.

Micrococcus subcanus Migula. (No 17, Lembke, Arch. f. Hyg., 26, 1896, 311; Mıgula, Syst d. Bakt., 2, 1900, 202) From feces Winslow and Winslow (loc. cit, 224) state that this is apparently a synonym of Micrococcus candicans Flugge.

Micrococcus subcarneus Migula (M1crococcus carnicolor Kern. Arb bakt Inst. Karlsruhe, 1, Heft 4, 1897, 495; not Micrococcus carnicolor Frankland and Frankland, Micro-organisms in water, 1894, 503; Migula, Syst d. Bakt , 2, 1900, 181.) From the intestines of doves (Columba livia and Columba oenas). Hucker (loc. cit., 26) states that this may be identical with Micrococcus roseus Flugge.

Micrococcus subcitreus Migula. (Citronengelber Micrococcus. Keck. Ucber das Verhalten der Bakterien im Grundwasser, Dorpat Dissertation, 1890, 60; Migula, Syst. d. Bakt , 2, 1900, 147.) From air and water Winslow and Winslow (loc. cit., 216) consider this a synonym of Micrococcus flavus Trevisan. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 249.

Мистососсия subcretoceus (Kreideweisserverflussigender Micrococcus, Keck, Inaug. Diss., Dorpat, 1890. 64; Migula, Syst. d. Bakt., 2, 1900, 107.) Winslow and Winslow (loc. cit. 199) state that this species appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus subflarescens Bergey et al (Manual, 1st ed., 1923, 61.) From dust and water. Hucker (loc. cit., 9) considers this a synonym of Micrococcus flarus Trevisan. For a description of this species, see Bergey et al., Manual,

5th ed., 1939, 246,

Micrococcus subflavidus Migula. (Micrococcus tetragenus subflavus v. Besset, Beitr. z. allem. Path, u. path. Anat., 6, 1889, 347; Migula, Syst. d. Bakt., 2, 1900, 190; Micrococcus subflavus Chester, Man Determ. Bact., 1901, 96; not Micrococcus subflavus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 159.) From normal nassi mucus. Winslow and Winslow (loc. cit 184) state that this is apparently a syn onym of Micrococcus aureus Zopf; while Hucker (loc. cit., 7 and 21) considers it probably identical with Micrococcus luteus Cohn, Micrococcus varians Migula, or Gafikya tetragena Trevisan.

Micrococcus subflavus Flügge. (Gelbweisser Diplococcus, Bumm, Die Mikrogonorrh. Schleimhauterkr., 1 org d Aufl., 1885 and 2 Aufl., 1887, 20; Flügge, Die Mikroorganismen, 2 Aufl., 1886, 159, Neisseria subflava Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 32; Diplococcus subflavus Lisenberg, Bakt. Diag., 3 Aufl., 1891, 307; not Micrococcus subflavus Chester, Man. Determ. Bact., 1901, 96.) From gonorrheal pus. Winslow and Winslow (loc. ed., 216) consider this a synonym of Micrococcus flavus Trevisan. For a description of this species, sec Bergey et al, Manual, 5th ed., 1939, 248.

Micrococcus subjuscus Matzuschita (Cent. f. Bakt., I Abt., 29, 1901, 383.) From dust. Similar to Micrococcus fuscus Adametz.

Micrococcus subgiteus Migula (Micrococcus gibus Hennet, Arb. a bak. Inst Karlsruhe, I, Heft 1, 1894, 78, not Micrococcus giteus Losski, Inaug. Dess, Dorpat, 1832, 60, Migula, Syst d. Bakt, 2, 1900, 132.) From cheese Winslow and Winslow (doc ctd., 220) regard this as a synonym of Micrococcus luteus Cohn.

Micrococcus aubgranulatus Migdla (Micrococcus crircus granulatus Freund, Inaug. Diss, Irlangen, 1893, 27, Migula, Syst. d. Bakt., 2, 1900, 148, Micrococcus granulatus v Bagarenski, Cent f Bakt., II Abt., 15, 1905, 7.) From the oral cavity. Winslow and Winslow (loc ct., 216) consider this a synonym of Micrococcus flavus Trevisan For a description of this species, see Bergey et al., Manual, 5th ed., 1909, 249.

Micrococcus subgraeus Migula (Grauer Coccus, Mascelek, Jahresb d Kom - Oberrealschule, Leitmeritz, No 8, 1887, 61, Migula, Syst d Bakt, £, 1900, 01) From water Winslow and Winslow (Ice. cif., 1993) stafe that this appears to be a synonym of Micrococcus adbus Schroeter, while Hucker (Ice. cif., 191) regards its as synonym of Micrococcus ureae Cohn.

Micrococcus sublactus Migula (No 27, Lemble, Arch I. Hyg., 29, 1897, 329, Migula, Syst. d. Bakt, 2, 1900, 210) From feecs Winslow and Winslow (loc. cit., 190) state that this appears to be a synonym of Micrococcus albus Schroeter, while Hucker (loc. cit., 10) regards it as a synonym of Micrococcus freudemerichis Guillebeatu or of Micrococcus ureae Cohn. Micrococcus sublicatum Mirgula (No

20, Lembke, Arch. f. Hyg. 26, 1890, 317; Migula, Syst. d Bakt. 2, 1900, 205) From feces Hucher (loc cit, 15) considers this a synonym of Micrococcus albus Schroeter.

Micrococcus subluteus Weiss (Arb.

bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 198.) From vegetable infusions

Micrococcus aubutueus Migula (Micrococcus albidus Henrici, Arb. bakt. Inst. Karlsruhe, J. Heft I, 1894, 75; not Micrococcus albidus Losski, Inaug Diss., Dorpat, 1893, 55, Migula, Syst. d. Bakt, 2, 1900, 105.) From Swiss cheese. Winslow and Winslow (loc. cit, 199) state that this appears to be a synonym of Micrococcus albius Schroeter.

Micrococcus subochraceus Migula. (No. 30, Lembbe, Arch. f. Hyg., 29, 1897, 332, Migula, Syst. d. Bakt., 2, 1900, 215.) From feces. Winslow and Winslow (loc. ett., 216) regard this as a synonym of Micrococcus flavus Trevisan

Micrococcus subroceus Migula (Micrococcus roseus Lisenberg, Baht. Diag., 3 Aufl , 1891, 408; Migula, Syst d. Bakt, 2, 1900, 170, Micrococcus rubeccens Chester, Man Determ Bact, 1901, 103) From the sputum of an influenza patient Hucker (loc cit., 20) intest that this may be identical with Micrococcus roseus Fluego.

Microroccus subterraneus Hansgirg (Hansgurg, Oest Bot Zeitschr, 1858, No 7-8, 8, Staphylococcus subterraneus DeToni and Trevisum in Saccardo, Sylloge Fungorum, 8, 1889, 1075 ) From damp walls of wine cellars in Bohemua

Micrococcus subtilis Migula. (Diplococcus, Kirchner, Ztschr f. Hyg., 9, 1890, 528, Migula, Syst d Bakt, 2, 1300, 192.) Found in the sputum and blood of influenza patients

Micrococcus sr.culentus Henrici. (Arb. bakt Inst Karlsrube, 1, Heft 1, 1894, 63 ) From Swiss cheese. Winslow and Winslow (loc. cit., 221) state that this is apparently a synonym of Micrococcus candicans Plugge.

Micrococcus sulphureus Zimmermann (Bakt unserer Trink- u. Nutzwässer, Chemnitz, I Reihe, 1890, 81.) From water. Winslow and Winslow (Ioc cit., 20) regard this as a synonym of Micrococcus Intens Cohn.

Micrococcus suis Burrill. (Bacillus

suis Detmers, Rept. U. S. Dept. Agric. for 1878; Burrill, Amer. Nat., 17, 1883, 320.) From blood of hogs sick with

swine plague or hog cholera.

Micrococcus syphiliticus Migula. (Coccen, Disse, Deutsche med. Wehnschr., 15, 1887, 888; Migula, Syst. d. Bakt., 2, 1900, 218.) This may be synonymous with Micrococcus candicans Flügge.

Micrococcus tardigradus Trevisan. (Micrococcus flavus tardigradus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 175; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 34; Micrococcus sulfureus β-tardigradus Lehmann and Neumann, Bakt. Diag , 1 Aufl., 2, 1896, 163; Micrococcus sulfureus var. tardigradus Lohnis and Pillai, Cent. f. Bakt., II Abt., 19, 1907, 92.) From air; also found in water Winslow and Winslow (loc cit, 220) regard this as a synonym of Micrococcus luteus Cohn. Micrococcus tardior Migula (Diplo-

coccus flavus Inquefaciens tardus Unna and Tommasoli, Monatshefte f. prakt. Dermatol., 9, 1889, 56; Migula, Syst. d. Bakt, 2, 1900, V and 141; Micrococcus epidermis Chester, Man. Determ. Bact., 1901, 97; Diplococcus flavus-liquefaciens Chester, thd.) From eczema. Winslowen and Winslow (loc. cit., 216) regard this as a synonym of Micrococcus flavus Trevisan, while Hucker (loc. cit., 11) regards it as a synonym of Micrococcus cutrus Migula.

Micrococcus tardissimus (Trevisan) Micrococcus, Bumm, Mikroorg. d. gonorrh. Schleimhauterkr., 1 Aufl., 1885; Diplococcus albicans tardissimus Flugge, Die Mikroorganismen, 2 Aufl, 1889, 183; Neisseria tardissima Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 32; Micrococcus albicans tardissimus Sternberg, Man. of Bact., 1893, 882; Migula, Syst. d. Bakt., 2, 1900, 49 ) Found in vaginal secretions Winslow and Winslow (loc. etc., 205) regard this as a synonym of Micrococcus candidus Coln or of Gaffya

tetragena Trevisan; while Hucker (loc.

cit., 7) considers it a synonym of Micrococcus luteus Cohn or Micrococcus varians Migula.

Micrococcus tardus Migula. (Diplococcus albicans tardus Unna and Tommasoli, Monatshefte f. prakt. Dermatol., 9, No. 2, 1889, 49; Micrococcus albicans tardus Sternberg, Man. of Bact., 1883, 882; Migula, Syst. d. Bakt., 2, 1900, 59; Micrococcus eczemae Chester, Man. Determ. Bact., 1901, 86). From eczema. Winslow and Winslow (dec. cit., 216 and 221) regard this as a synonym of Micrococcus flavus Trevisan or of Micrococcus candicans Fluge.

Micrococcus tenacatis Chester. (No 43, Conn, Storra Agr. Exp. Sta. 7th Ann. Rept., 1895, 78; Chester, Man. Determ Bact., 1901, 83.) From milk from Uruguay. Winslow and Winslow (loc. cit., 220) state that this is apparently a synonym of Micrococcus candicans Flügge

Micrococcus tener Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 200) From a vegetable infusion.

Micrococcus tenuissimus Migula. (Micrococcus cumulatus tenuis v. Besser, Beitr. z. path. Anat., 6, 1889, 347; Migula, Syst. d. Bakt., 2, 1900, 55; Micrococcus cumulatus Chester, Man. Determ. Bact, 1901, 87.) Frequently found in human ansal mucus. Winslow and Winslow (loc. cit., 205) regard this as a synonym of Micrococcus candidus Cohn or of Gaffiya tetragena Trevisan.

Micrococcus tetragenus aurers Boutron. (Thèse, Paris, 1893; Abst. in Cent. f. Bakt., 16, 1894, 971.) Hucker (loc. cit, 21) regards this as a synonym of Gaffiya tetragena Trevisan.

Micrococcus tetragenus concentricus Schenk. (Allg. Wien. med. Zeitung, 1892, 81 and 92; Abst. in Cent. f. Bakt., 13, 1893, 720.) From feces. Motile.

Micrococcus tetragenus-pallidus Chester. (Micrococcus tetragenus pallidus, Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 531; Chester, Man. Determ. Bact., 1901, 93) Tom dust. Probably a variety of Micrococcus versatilus Chester, see below. Micrococcus tetragenus-vividus Chester. (Nicrococcus tetragenus evvidus Dyar, Ann. N. Y. Acad. Sci. 8, 1895, 35 Chester, Man. Determ. Bact., 1901, 102) From dust. Probably a variety of Micrococcus pergulus. Chester, see below.

Micrococcus tetras Henrici (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1824, 60, Pediococcus tetras Pribram, Klassifikation der Schizomyceten, 1933, 46) From cheese. Winslow and Winslow (loc. cit., 221) state that this species is apparently the same as Micrococcus condicans Fluere.

Micrococcus thermophilus Hansgirg (Ocstr. Bot. Ztschr, No. 3, 1888, 5) From hot springs.

Micrococcus toxicatus Burrill (Amer. Nat., 17, 1883, 319) From poison ivy and other plants in the genus Rhus

Micrococcus trachomatis Migula (Trachomoroccus, Sattler, in Zehender, Klin. Monatabl, 1881, Trachomoroccus, Michel, Arch. f. Augenheilk, 16, 1886; Neisseria micheli Trevisan, I generi e le specie delle Batteriace, Milan, 1889, 22; see Baumgarten, Lehrb d path Mjklol., 1, 1890, 421; Migula, Syst d Bakt., 2, 1900, 67) Winslow and Winslow (Ioc. cit., 205) consider this to be a synony of Micrococcus candidus Cohn or of Goffiku tetragena Trevisan

Micrococcus tributyrus Stark and Scheib. (Jour. Dairy Sci , 19, 1936, 210 ) From butter.

Micrococcus tritice Priliceux (Maladies des plantes agricoles, 1, 1895, 7, not Micrococcus tritice Köck, Monatshefte f Landwirtschaft, 1909, 217, quoted from Lehman and Neumann, Bakt Deg. 5 Aufl., 2, 1912, 653) Considered pathogenic on wheat.

Micrococcus tuberculosus Migula (No. 23, Lemble, Arch I. Hyg., 29, 1897, 325; Migula, Syst. d Bakt., 2, 1900, 214.) From feces: Winslow and Winslow (loc. ct., 221) state that this is apparently a 8, nonymod Micrococcus candicana Flagge. Micrococcus typhoideus Migula. (Coccus A, Foutin, Bakt. Untersuch v. Higel, Wratsch, 1859, No. 49 and 50; see Cent. f. Bakt. 7, 1800, 373; Migula, Syst. d. Bakt. 2, 1800, 94; Micrococcus alpha Chester, Man Determ. Bact., 1901, 93 ) From hail. Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schrocter; while Hucker (loc cit. 25) states that it may be identical with Micrococcus roseus Flarms.

Micrococcus ulceris de Luca (Gazzetta degli Ospitali, 1886, Abst. in Cent. f Bakt, 1, 1887, 333; Micrococcus ulceris mollis de Luca, ibid) From the secretion of a venereal ulcer.

Micrococcus ulmi Brussoff (Cent. f. Bakt, II Abt, 65, 1925, 261.) Isolated from diseased elm trees.

Micrococcus umbilicatus Weiss (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 186) From a bean infusion Hucker (loc cit, 12) considers this a synonym of Micrococcus aureus Zopf

Mttrococcus ureae Migula (Torule ammoniacale, Pasteur, Ann de Chim, et de Phys., 3 sér., 64, 1862, 52; van Treghem, Comp. rend Acad. Sci., Paris, 58, 1861 210, Torula ureae Lea, Jour. of Physiol., 11, 1890, 226; Migula, in Engler and Prantl, Die natürl. Plannenfam, 1, 1a, 1895, 17) From urne May not be the some as Mttrococcus ureae Columbia.

Micrococcus urinathus De Tuni and Trevisan (Micrococcus albus urinae Doyen, Jour d comaiss médie, No 44, 1859, 108, De Toni and Trevisan, in Saccardo, Sylboge Funcorum, 8, 1889, 1076) From urine. Hucker (Iec. cit, 15) considers this a synonym of Micrococcus albus Schroeter

Micrococcus uruguat Chester, (No. 40, Conn, Storrs Agr. Eyp. Sta. 7th Ann. Rept., 1955, 78, Chester, Man Determ. Bact., 1901, 100) From milk from Urugusy. Windon and Window (loc. cit., 216) regard this as a synonym of

Micrococcus flavus Trevisan; while Hucker (loc. cil., 10) regards it as a synonym of Micrococcus conglomeratus Migula.

Micrococcus utriculosus Migula. (No. 20, Lembke, Arch f. Hyg., 29, 1897, 327; Migula, Syst d. Bakt. 2, 1900, 190.) From feces Winslow and Winslow (loc. cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter.

Micrococcus caraans lactis Conn. (Storrs Agr. Exp. Sta. 12th Ann. Ropt., 1900, 37.) From milk, cream, dust. According to Weigmann (In Lafar, Handb. d. techn Mykologie, 2, 1905, 13) this is identical with Staphylococcus mastitis albus Hucker (loc. cit., 11) regards it as a synonym of Micrococcus cutreus Musula.

Micrococcus variococcus Muller-Thurgau and Osterwalder. (Cent. f Bakt., II Abt., 36, 1913, 236.) From wine.

Micrococcus versatulis Chester (Micrococcus tetragenus febris flavae Finlay; Micrococcus tetragenus versatulis Sternberg, Report on ettology and prevention of yellow fever, Washington, 1891, 164, Chester, Man Determ. Bact., 1901, 102.) Isolated from the excrement of mosquitoes which had sucked the blood of yellow fever patients; and from dust Winslow and Winslow (loc cit., 210) regard this as a synonym of Micrococcus fagus Trovisan.

Micrococcus versicolor Flugge. (Die Mikroorganismen, 2 Aufl., 1886, 177.) From dust Winslow and Winslow (loc. cit., 220) consider this a synonym of Micrococcus luteus Cohn.

Micrococcus resicae Heim. (Lehrb. d. Bakt, 2 Aufl, 1898, 297.) From acid urine Winslow and Winslow (loc cit., 224) state that this is apparently a synonym of Micrococcus candicans Flügge

Micrococcus vesicans Harman. (Jour. Path. and Bact , 9, 1904, 1) Considered the cause of veld sore, a disease of Africa and tropical Australia

Micrococcus resicosus Weiss (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 203.) From a vegetable infusion

Hucker (loc. cit., 8) considers this species identical with either Micrococcus luteus Cohn or Micrococcus rarians Migula.

Micrococcus vesiculiferus Migula. (No. 28, Lembke, Arch. I. Hyg., 29, 1897, 30); Migula, Syst. d. Bakt., 2, 1900, 211.)
From feces. Winslow and Winslow (loc. cit., 220) regard this as a synonym of Micrococcus luteus Cohn

Micrococcus rincenzii Chester. (Micrococcus tetragenus citreus Vincensi, La Riforma Med., 1897, 758; Chester, Man Detorm. Bact., 1901, 103.) From the submaxillary lymphatic gland of a child Winslow and Winslow (loc. cit, 220) regard this as a synonym of Micrococcus luteus Cohn.

Micrococcus vini Migula. (Micrococcus saprogenes vini I, Kramer, Bakt. in Beziehungen z. Landwirtsch. u. d. landwirtsch-techn. Gewerben, II Teil, 1892, 139; Migula, Syst. d. Bakt., 2, 1909, 118; From wine. Winslow and Winslow (loc cit., 199) state that this appears to be a synonym of Micrococcus albus Schroeter; while Hucker (loc. cit., 8) considers it identical with Micrococcus luteus Coha or Micrococcus carians Migula.

Micrococcus viniperda Schroeter. (Schroeter in Cohn, Kryptog -Flora V. Schlesien, 3, 1, 1886, 144) From dust, feces, etc.

Micrococcus viscosus Bergey et al. (Micrococcus lactis viscosus B, Conn. Esten and Stocking, Storrs Agr. Exp. Sta. Rept. for 1908, 109; Bergey et al., Manual, 1st ed., 1923, 68.) From psteurized milk. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 256. See Micrococcus lactur viscosus Sternberg.

Micrococcus viscosus lactis Conn (Storrs Agr. Exp. Sta. 12th Ann Rept. 1900, 44.) From milk.

Micrococcus viticulosus l'lugge. (Die Mikroorganismen, 2 Aufl., 1886, 173.) From dust and water. Winslow and Winslow (loc. cit., 205) consider this to be a synonym of Micrococcus candidus Cohn or of Gaffkya tetragena Trevisan

Micrococcus vulgaris Echstein (Zischr. f. Forst- u Jagdwesen, 20, 1894, 17; Abst. in Cent. f Bakt I. Abt, 18, 1895, 202; not Micrococcus vulgaris Viscos, Arb. bakt. Inst Karlsruhe, 2, Hoft 3, 1902, 193.) From insects.

Microoccus zanliogenicus (Freire)
Trevisan. (Cryptococcus zanliogenicus
Freire, Richerches sur la cause de la
fièvre jaune, Rio de Janeiro, 1884, Trevisan, I generie le specie delle Batteriace, Milan, 1889, 33 ) Isolated from
yellow fever and supposed by Freire to
be the cause of the disease Winslow
and Winslow (loc. cit., 199) state that
this appears to be a synonym of Microo-

cus albus Schroeter.

Micrococcus zenopus Schrie and Greenfield (Trans Royal Soc So Airica, 17, 1930, 300.) From an abscess in a toad (Xenopus sp.). For a description of this species, see Bergey et al., Manual, 5th ed., 1930, 213.

Micrococcus zerophilus Glage (Ztschr. f. Fleisch- u Milchhygiene, 10, 1900, 145) From coating on surface of dry wurst and similar meat products

Micrococcus zeae Serbinov (La Defense des Plantes, 2, 1926, 546) From flour, grain and seedlings of corn Was thought to be a cause of pellagra in South Russia.

Mitrococcus zonatus Henrici (Arb bakt. Inst. Karlsruho, 1, Heft 1, 1894, 68) From cheese. Winslow and Winslow (loc. ett, 224) state that this is apparently a synonym of Micrococcus candicans Tlaure.

Planococcus cases Migula (Micro-coccus No III, Adametz, Landwirtsch Jahrb, 18, 1889, 210, Migula, Syst d. Bakt., 2, 1900, 270) From Emmenthal cheese.

Flanococcus locflers Mugula (Löffler, Cent f. Bakt., 7, 1900, 637, Migula, Syst d. Bakt., 2, 1900, 273.) From colony on an old gelatin plate

Planococcus luteus (Adametz) Migula

(Diplococcus luteus Adametz, Mittell. d. oestert. Vers. Station I. Brauerei u. Malzerei in Wien, Heft I, 1888, 30; Neussrie lutea Trevisan, I generi e le specie delle Batteriacce, Mian, 1893, 32; Migula, Syst. d. Bakt, 2, 1900, 274.) Hucket (Doc. ett., 9) considers this species a synonym of Micrococcus flavus Trevisance)

Rhodococcus fulvus Winslow and Rogers (Jour. Inf. Dis., 8, 1906, 515; not Micrococcus fulvus Cohn, Beitr. 2. Biol. d. Pflanzen, 1, Heft 3, 1875, 181.) From soil, air and water.

Staphylococcus albicans Stigell. (Cent. f. Bakt, I Abt, Orig., 45, 1908, 489) Frobably intended for Micrococcus albicans amplus Tlugge.

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Staphylococcus albus lique/accus Sternberg. (White lique/jing staphylococcus, Escherich, Die Darmbakterien des Suglings, Stuttgart, 1886, 88, Sternberg, Manual of Bact., 1893, 607.) Found occasionally in the feces of healthy infants

Staphylococcus albus non liquefaciens Hlava (Sbornsk lékafský, II, Prague, 1887, 12 pp. sec Cent f. Bakt., 2, 1887, 688) Probably a synonym of Micrococcus albocercus Migula

Staphylococcus anaerobius Heurlin. (Bakt Unters d Keimgehaltes im Gemtalkanale d fiebernden Wöchnerin-Helsingfors. 1910. 120 ) See nen, Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, Paris, 1937, 1027; probably not the same as Staphy'ococcus angerobius Hamm. Die puerperale Wundinfektion, Berlin, 1912 Incompletely described. From genital tract. Staphylococcus anacrobius major Heur-

lin (loc cit, 120) From gental tract. Staphylococcus anaerobius minor Heurlin (loc. cit, 120) From gental tract.

Staphylococcus aureus sarcinformis Scanhauch (Klin Monatebl f Augenheilkunde, Jahrg, 8, 1909, 257, Abst in Cent. f. Bakt, I Abt., Ref., 45, 1910, 757.) Staphylococcus boits Ford (Staphylococcus pyogenes boits Lucet, Ann. Inst. Past., 7, 1893, 327; Ford, Textb. of Bact., 1927, 424.) Found in suppurative lesions of cattle.

Staphylococcus candidus Warrington. (Lancet, 1, 1888.)

Staphylococcus flavocyaneus Knaysi. (Jour. Bact., 43, 1942, 368.) Found as a contaminant in dissociation studies.

Staphylococcus flavus non pyogenes Frankel and Sanger. (Arch. f. path. Anat., 108, 1887, 286; Abst. in Cent. f. Bakt., 3, 1883, 281.) Found in endocarditis ulcerosa

Staphylococcus griseus Tavel. (Quoted from Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 173) From pus.

Staphylococcus griseus radiatus Viti. (Atti d. R. Accad d. Fisiocritici di Siena, Ser. IV., 2, 1891, Abst. in Cent. f. Bakt., 11, 1892, 672) From cases of endocarditis.

Staphylococcus habanensis Gibler. (Quoted from Fernandez, Cronica médico quirárgica de la Habana, 1891, No. 30, Abst. in Cent. f. Bakt., 11, 1892, 472.)

Isolated from the human eye.

Staphylococcus insectorum Krassilstschik. (Quoted from Paillot, Les maladies du ver à soie grasserie et dysenteries, 1928, 171.) From the intestinal

tract of the silkworm (Bombyx mori). Staphylococcus lactis acidi McDonnell. (Inaug Diss, Kiel, 1899, Abst in Cent. f. Bakt, II Abt., 6, 1900, 120)

Staphylococcus lelorri: Trevisan (Microbe des périfolliculites conglomérées, Lelorr, Soc. anatomique, May, 1884; Trevisan, I generi e le specie delle Batteriacee, Milan, 1889, 33.)

Staphylococcus liquefaciens aurantiacus Distaso (Cent. f. Bakt., I Abt., Orig , 59, 1911, 102.) From feces.

Staphylococcus muscae Glaser. (Amer. Jour. Hyg., 4, 1924, 411.) Causes a fatal infection in house flues (Muscadomestica). For a description of this species, see Bergey et al, Manual, 5th ed, 1939, 264.

Staphylococcus non pyogenes Savor. (Beitr. z. Geburtshilfe u. Gynäkol. v. Hegar, 2, Heft 1, 1898; Abst. in Cent. f.

Bakt., I Abt., 26, 1899, 642.) From urino-genital tract.

Staphylococcus pharyngis Bergey et al. (Manual, 1st ed., 1923, 56.) Found in the human nasopharynx in acute eatarrhal inflammation. For a description of this species, see Bergey et al., Manual, 5th ed., 1939, 265.

Staphylococcus putrificus Schottmuller. (Leitfaden f. d. Klinisch- Bakt. Kultur-Methoden, Berlin, Wien, 1923. Quoted from Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, Paris, 1927, 1027.)

Staphylococcus pyogenes liquefaciens albus Hlava. (Sborník lékařský, II, Prague, 1887, 12 pp.; Abst. in Cent. f. Bakt., 2, 1887, 688.) From small por pustules.

Staphylococcus pyogenes tenuis Scheibe (Inaug. Diss., Munchen, 1889; see Cent f. Bakt., 6, 1889, 186.) From middle ear infections.

Staphylococcus roseus Tavel. (Quoted from Lehmann and Neumann, Balt Diag, '1 Aufl., 2, 1896, 177.) Evidently identical with Micrococcus roseus Lehmann and Neumann or Micrococcus roseo-fulus Lehmann and Neumann

Staphylococcus salivarius Andrewes and Gordon. (35th Ann. Rept. Local Govt. Board London, 1905-06, 558) From saliva. Probably Micrococcus candidus Cohn.

Staphylococcus ureae candidus Lundström. (Festschr. d. path.-anat. Iast. 2. Andenken a. d. 250 jahrige Bestchend finnland. Univ. Helsingfors, 1890; abst in Cent. f. Bakt., 0, 1891, 672 ) From urine Probably Micrococcus ureae Cohn.

Staphylococcus ureae non pyogenes Barlow. (Arch. f. Dermat. u. Syph., 1893; Abst. in Cent. f. Bakt , 14, 1893, 456.) From cases of cystitis.

Urococcus dowdeswelli Miquel. (Ann. de Micrographie, 5, 1893, 209.) Ferments urea.

Urococcus van tieghemi Miquel (loc. cit., 161). Ferments urea.

## Genus II Gaffkva Trenison \*

(Trevisan, Atti d. Accad. Fisio-Medico-Statistica in Milano, Ser. 4, 3, 1885, 106; Tetracoccus Klecki, Cent. f Bakt , 15, 1891, 360, not Tetracoccus Orla-Jensen, The Lactic Acid Bactoria Mam Acad Sci Danemark Sec. Sci., 8 ser 5, 1919, 151, Tetradiplococcus Bartoszewicz and Schwarzwasser, Cent f. Bakt., II Abt . 21, 1908, 614.) Named for Prof. Georg Goffly, 1850-1918, Berlin.

Occur in the animal body and in special media as tetrads, while in ordinary culture media they occur in pairs and pregular masses. Aerobic to anagrobic. Gram-posttive. Parasitic organisms.

The type species is Gafflug tetrageng (Gaffly) Trevisan.

Ken to the species of genus Gaffkva.

- I. Facultative aerobe.
- II. Strict annerobe
- 1. Gaffkva tetragena (Gaffkv) Trevisan. (Micrococcus tetranenus Gaffley, Arch. f. Chirurg., 28, Heft 3, 1883, 500, Trevisan, Atti d Accad, Fisio- Medico-Statistica in Milano, Ser. 4, 5, 1885, 106, Micrococcus tetragenus senticus Boutron. Thesis, Paris, 1893; Abst in Cent f. Bakt , 16, 1891, 971; Micrococcus tetragenus albus Boutron, thid .: Merista septica Hueppe, Principles of Bacteriology (Ung. trans.), 1899, 179; Sareing septica Hueppe, ibid.: Sarcina tetragena Migula, Syst. d. Bakt., 2, 1900, 225; Merista tetragena Vuillemin, Ann. Mycologie, Berlin, 11, 1913, 525; Staphylococcus tetragenus Holland, Jour. Bact . 5, 1920, 221; Tetracoccus septicus Neveu-Lemaire, Précis Parasitol Hum , 5th ed , 1921, 18: Pediococcus tetragenus Pribram, Klassifikation der Schizomseeten, 1933, 46) From Greek, tetra (telara), four, M L. gener, producing
- Spheres: 0 6 to 0.8 micron in size, with pseudocapsule (in lasty fluids) surrounding four of the elements showing typical tetrade. Gram positive

1. Gaffkva tetragena

2. Gafikya anaerobia.

Gelatin colonies: Small, 1 to 2 mm, in diameter, white convex.

Gelatin stab. Thick, white surface growth. No honefaction.

Agar colonies Circular, white, smooth, glistening, entire Reimann (Jour Bact . \$1, 1936, 285) has described eleven colony form variants for this species

Agar slunt: White, moist, glistening, Broth Clear, with gray viscous sedi-

ment Litmus milk: Slightly acid.

Potato . White, viscul.

Indote not formed Natrates not produced from nitrates.

Starch not hydrolyzed.

Ammonium salts not utilized.

Acid from glucose, lactore and glycerol.

No 11-S formed

terobic, facultative

Pathogenic for mice and guines pigs; rabbits less susceptible.

Ontimum temperature 37°C.

Source: Isolated from soutum in tuberculosis, also from air and skin Habitat: Mucous membrane of respira-

tory tract

<sup>\*</sup> Revised by Prof. G. J. Hucker, N. Y. State Experiment Station, General New York March, 1913.

 Gafikya anaerobia (Choukévitch) Prévot. (Tetracoccus anaerobius Choukévitch, Ann Inst. Past., 25, 1911, 349;
 Micrococcus tetragenes anaerobius Hamm, Die puerperale Wundinfektion, Berlin, 1912;
 Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 293 | From Greek, an, without; aer, air, bos. life.

Spheres: About 1.0 to 1.5 microns, occurring in tetrads, sometimes in groups of eight Gram-positive.

Gelatin No liquefaction.

Deep agar colonies: After 24 to 48 hours, small, grayish, 2 to 3 mm. in diameter Abundant production of gas which breaks up the agar.

Broth, Poor growth. Slight sediment. Milk: Unchanged

Coagulated proteins not digested.

Optimum temperature 37°C. No growth at 22°C.

Non-pathogenic for guinea-pigs or rabbits.

Strict anaerobe.

Distinctive characters: Prefers acid

Source: Isolated from the female genital tract, isolated from the large intestine of a horse.

Habitat Probably widely distributed in natural cavities of man and animals

Appendix: The following species have been placed in the genus Gaffhya or in the genus Tetracoccus,

Gaffkya archeri Trevisan (A black micrococcus, Archer, Quart. Jour Mieroscop. Sci., 1874, 321; Trevisan, I genera ele specie delle Batteriacee, Milan, 1889, 27.)

Gafikya grandıs DeToni and Trevisan. (Mıcrocoque des reins et des ulcéres syphilitiques de la peau, Babes, in Cornil and Babes, Les Bactér., 2nd ed., 1886, 782, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1042.)

Gaffkya mendozac DeToni and Trev-

(Micrococcus tetragenus and Micrococcus tetragenus mobilis ventriculi Mendoza, Cent. f. Bakt., 6, 1889, 567; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1043; Planococcus tetragenus Migula, Syst. d. Bakt., 2, 1900. 269; Micrococcus mendozae Chester, Man. Determ. Bact., 1901, 81; Sarcina letragena Winslow and Rogers, Jour. Inf. Dis, 3, 1906, 515; Planomerista ventriculi Vuillemin, Ann. Mycolog., Berlin, 11, 1913, 525.) Motile. Isolated from the contents of the stomach. Hucker (N. Y. State Exp. Sta. Tech. Bull. No. 102, 1921, 21) regards this as a synonym of Gaffkya tetragena Trevisan.

Gaffkya tardissima (Altana) Bergy ct. (Tetragenus tardissimus Altana, cnt. f. Bakt., I Abt., Orig., 48, 1909, 42; Bergey et al., Manual, 2nd ed., 1935, 59.) From a natural infection of guine pigs. See Manual, 5th ed., 1939, 200 for a

description of this species.

Gafkya verneti Corbet. (Organism No. 21, Denier and Vernet, La Caoutchouc, 17, 1920, 1919); Corbet, Quart Jour. Rubber Rescarch Inst., Mahya. 1, 1930, 113.) From the latco of the Tar rubber tree (Hevea brasiliensis). For a description of this species, see Manual, 5th ed. 1939, 269.

Tetracoccus carneus halophilus Horowitz-Wlassowa. (Cent. f. Bakt., II Abt., 85, 1932, 16.) Isolated from salted intestines (Wiener skins).

Tetracoccus casei Orla-Jensen. (The Lactic Acid Bacteria, 1919, 80.) From cheese. Probably identical with Micrococcus freudenreichti Guillebeau.

Tetracoccus mastitidis Orla-Jensen (fcc. cit., 81). From milk of a woman nih mastitis. Orla-Jensen thinks this is identical with the staphylococcus that causes mastitis in cows, i.e., Moreoccus pyogenes var. aureus Zopf.

Tetracoccus mycodermatus Orla-Jensen (loc. cit., 81). From Camembert cheese

## Cenus III Sareina Goodein .

(Goodsir, Edinborough Med, and Surg. Jour., 1842, 430; Lactosarcina Beijerinek-Arch, néerl, d. sci. exact., Ser. 2. 13, 1908, 359; Urosarcina Miquel, Ann. Micror. 1. 1888. 517: Planosareina Migula, Arb. Bakt, Inst. Karlsruhe, I. 1891, 236, Pseudosare cing Löhnis, Handh d. landuirtsch Bakt. 1910, 449 (Pseudassareum Mazé Compt. rend, Acad. Sci. Paris 137 1003 857) Sparospressing Orla-Jensen Cent ( Balt 11 Abt., 22, 1909, 340: Paulosarcina Enderlein, Sitzber, Gesell, Naturf, Berlin, 1917. 319: Phacelium Enderlein, thid 319. Zumasareina Smit. Die Gärunessareinen. Pflanzenforschung, Heft 14, 1930, 26, Buturisarcina Kluvver and Van Niel, Cent. f. Bakt. II Abt., 94, 1936, 400. Methanosarcina Kluvver and Van Niel, ibid.) From Latin sarcina, packet, bundle

Division occurs, under favorable conditions, in three planes, producing regular packets. Usually Gram-positive Growth on agar abundant, usually with formation of yellow or orange pigment Glucose broth slightly acid, lactose broth generally neutral. Gelatin frequently househed. Natrates may or may not be produced from nitrates Sanronhytes and facultative parasites.

The type species is Sarcina centriculi Goodsir.

## Key to the success of genus Sarcina.

- I. Microaerophilic to anaerobic
  - Do not produce methane. Sub-genus Zumo-A. No growth without sugars sarcina Smit (Die Garungssareinen Pflanzenforschung, Heft 11, 1930, 26).
    - Slow congulation in litmus milk 1. Cellulose reaction positive
      - 1 Sarcing rentricula
    - Litmus milk not coamisted. 2 Collulose reaction negative 2 Sarcina marima
  - B. Does not utilize sugars Produces methane Sub-genus Methanosarena
  - Kluyver and van Nicl (Cent f Bakt, II Abt, 94, 1936, 400). 3. Sarcina methanica.
- II Aerobic.
- A. No endospores present. Sub cenus Sarcinococcus subgen, nor I. Not halophilie
  - a. Non-matile.
    - - b. Yellow pigment produced Nitrites not produced from nitrates. c. Milk alkaline, congulated
        - 4 Sarcina lutea.
          - ce Milk alkaline; not coagulated
        - 5 Sarcina flora. bb. Orange pigment produced Natrates produced from natrates
      - 6 Sateina autantiata az. Mobile.

    - 7 Sarcina citrea. 2. Halphilie red chromogen
    - 8 Sarcina littoralis B. Indisputes present Motile. Sub genus Sporoidreina Orla Jenson (Cent. f Bakt . H Abt., 22, 1929, 3191

9. Sarcina Litere.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva. New York, March, 1913

1. Sarcina ventriculi Goodsir. (Goodsir, Edinborough Med. and Surg. Jour., 57, 1812, 430; Merismopedia goodsirii Husemann, De anim. et végét., 18-, 13; Merismopedia ventriculi Robin, Histoire des végét, parasites, 1853, 331; Anaerobic sarcina, Beijerinck, Proc. of Section of Sciences, Kon. Akad. v. Wetensch., Amsterdam, 7, 1905, 580; Zymosarcina ventriculi Smit, Die Gärungssarcinen. Pflanzenforschung, Jena, Heft 14, 1930, 26; Sarcina beijerincki Prévot, Ann. Sci. Nat., Sér. Bot., 16, 1933, 205.) From Latin, ventriculus, the stomach.

Description taken in part from Smit (loc. cit.).

Large spheres: 3.5 to 10 microns, occurring in packets of 8, 16, 32 or more elements. Non-motile. Gram-positive.

Cellulose reaction positive Growth occurs only in sugar media.

Gelatin: No liquefaction.

containing peptones

Deep glucose agar colonies: Multi-

lenticular, surrounded by a cloudy zone. Abundant gas Glucose agar slant. Round, whitish

colonies, several millimeters in diameter. broth: Abundant. No growth. Abundant gas. Acid. turbidity.

Plain peptone water: No growth

Sugar peptone water. Abundant growth. Gas. Indole not formed Milk: Slow growth Acid and coagulation.

Coagulated proteins not attacked.

Acid and gas from glucose, fructose, sucrose, maltose, lactose and galactose. No acid from vylose, arabinose, raffinose, mannitol, dulcitol, salicin, starch, glycerin and inulin.

Neutral red broth changed to fluorescent yellow.

Utilizes pentones, wort and yeast water as sources of nitrogen Cannot utilize amino acida or inorganic nitrogen.

Principal products of metabolism are carbon dioxide and ethyl alcohol.

Nitrites not produced from nitrates Non-pathogenic.

Optimum pH 1.5 to 50. Limits of pH 0.9 to 9.8.

Temperature relations: Ontimum 30°C Maximum 45°C. Minimum 10°C. Kille in ten minutes at 65°C.

Microaerophilic to anaerobic.

Source: Isolated from a disease Habitat: Garden soil, dust, sand, mud

the stomach.

2. Sarcina maxima Lindner. (Lind ner, Die Sarcina-Organismen der Gär ungsgewerbe. Inaug. Diss., Berlin, 1888 51; Also abstract in Cent. f. Bakt 4, 1888, 427; Zymosarcina maxima Smit Die Gärungssareinen. Pflanzenforsch ung, Heft 14, 1930, 22; Butyrisarcini

maxima Kluyver and van Niel, Cent. f Bakt., II Abt., 84, 1936, 400.) From Latin maxima, largest. Description from Weinberg, Nativelle and Prévot, Les Microbes Annérobies

1937, 1030 and from Smit, loc. eil. Large spheres: 4.0 to 4.5 microns, or curring in regular packets of 8, 16, 32 or Non-motile. Grammore elements. positive.

Growth occurs only in sugar media, containing peptones.

Gelatin : No liquefaction.

colonies

Deep glucose agar colonies: Multilenticular. Abundant gas produced. Glucose agar slant: Round, whitish

Glucose broth: Abundant growth, flaky, gaseous, marked acidification. Disagreeable butyric odor. No turbidity.

Abundant pentone water: Sugar growth, flaky, gascous, followed by acid-

ification. Milk: Not congulated.

Coagulated proteins not attacked. Cellulose reaction negative. Acid and gas from glucose, fructose,

galactose, maltose, sucrose and lactose. Neutral red broth changed to fluores. cent yellow.

Utilizes peptones, yeast water or broth as source of nitrogen. Cannot utilize amino acids or inorganic nitrogen

Principal products of metabolism are carbon dioxide, butyric and acctic acids, Non-pathogenic.

Limits of pH 1.0 to 9 5.

Temperature relations, Optimum 30°C Maximum 40°C. Minimum 15°C. Killed in twenty minutes at 55°C

Microaerophilic to anaerobic

Source: Isolated from fermenting malt mash.

Habitat: Acidified flour pastes, wheat bran; seldom in soils. Also intestinal contents of guinea nics (Crecelius and Rettger, Jour. Bact., 46, 1943, 10).

3. Sarcina methanica (Smit) Weinberg et al. (Methannsarcine, Sobngen, Inaug. Diss , Delft, 1906, 104, Zymosarcina methanica Smit. Die Garungssarcinen Pflanzenforschung, Heft 14, 1930, 25; Methanosarcina methanica Kluyver and Van Niel, Cent. f. Bakt., II Abt , 94, 1936, 400; Barker, Arch. f. Mikrobiol, 7, 1936, 420; Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, 1937, 1032.) From M. L. methanum, methane; M. L. methanicus, related to methane.

Description from Weinberg, Nativelle and Prévot (loc. cit ) and Smit (loc cit ) Spheres: 20 to 25 microns, occurring

in packets of 8 or more cocci. Non-motile. Gram-variable

Growth in solutions of calcium acetate and possibly butyrate and inorganic ammonium salts. Carbon dioxide is needed for growth.

In acetate-agar (with addition of some H2S and NaHCO2); Colonies of 50 to 100 microns are formed, showing gas formation.

Cultural characters as yet unknown. Peptones not attacked.

Cellulose reaction negative.

Utilizes ammonium salts as source of nitrogen. No organie nitrogen compounds utilized.

Carbohydrates not fermented. Ethyl alcohol is not fermented.

Principal products from the metabolism of calcium acetate and butyrate are methane, carbon dioxide and calcium carbonate.

Non-pathogenic.

Optimum temperature 35° to 37°C.

Strict anaerobe, Killed by a short contact with the air

Distinctive characters: Utilizes ammonium salts and acyclic acids producing methane and carbonic acid. Source: Sediment in methane fer-

mentation (Weinberg et al.). Isolated from mud (Smit).

Habitat: Swamp waters and mud: fermenting sewage sludge.

4 Sarcina lutea Schroeter (Kryptog Flora v. Schlesien, 3, 1, 1886, 154; also see Klein, Microorganisms and Disease, 1885, 43, Eisenberg, Bakt, Diag., 1 Aufl., Taf 2, 1886; Flugge, Die Mikroorganismen, 2 Aufl., 1886, 179, Frankland and Frankland, Phil Trans, London, 178, B. 1888, 265.) From Latin luteus. vellow.

Spheres 1.0 to 15 microns, showing packets in all media. Gram-positive. Gelatin colonies Circular up to 5 mm. in diameter, sulfur-yellow, sinking into

Gelatin stab Slow infundibuliform houefaction

Agar colonies. Yellow, coarsely granular, circular, raised, moist, glistening, entire margin

Agar slant, Sulfur to chrome yellow, smooth, soft

Broth Clear with abundant yellow sediment

Latmus milk Congulated, becoming alkaline

Potato Sulfur to chrome vellow. raised; sometimes limited growth.

Slight indole formation

the medium

Nitrates generally produced from nitrates

No acid from glucose, lactose or sucrose.

Hydrogen sulfide is formed.

Aerobic.

Aerobic.

Optimum temperature 25°C.

Habitat: Air, soil and water, skin
surfaces

Sarcina flava De Bary. (Vorlesungen uber Bakterien, 1887, 151; Sarcina fliquefaciens Frankland and Frankland, Philos. Trans. Roy. Soc. London, 178, B, 1888, 267.)
 From Latin, flavus, yellow. Spheres: 1.0 to 20 microns, occurring in packets of 16 to 32 cells. Gram-positive.

Gelatin colonies: Small, circular, yellowish.

Gelatin stab: Slowly liquefied.

Agar slant : Yellow streak

Broth: Slowly becoming turbid with whitish, later yellowish sediment.

Litmus milk: Alkaline, not coagulated. Potato. Yellow streak

Indole not produced.

Indole not produced.

Nitrites not produced from nitrates. Aerobic.

Optimum temperature 30° to 35°C Habitat: Air, water, soil

6. Sarcina aurantiaca Flugge (Die Mikroorganismen, 1886, 180; For description see Frankland and Frankland, Phil. Trans. Roy. Soc. London, 178, B, 1888, 266; Paulosarcina aurantiaca Enderlein, Sitzungsber, Ges Naturf. Freunde, Berlin, 1917, 319.) From M. L, aurantiacus, orange-colored.

Spheres developing packets in all

media. Gram-positive.

Gelatin colonies: Small, circular, dark yellow, entire margin, sinking into the medium.

Gelatin stab: Infundabuliform liquefaction.

Agar slant: Slightly raised, orange yellow to orange red, soft, smooth. Broth. Flocculent turbidity, with

abundant sediment.

Litmus milk: Coagulation and digestion.

Potato: Raised, yellow-orange, glistening to dull, granular.

ng to dull, granular.
Slight indole formation.

Nitrites not produced from nitrates. No H<sub>2</sub>S produced.

Aerobic.

Optimum temperature 30°C. Habitat: Air and water.

7. Sarcina citrea (Migula) Bergey et al. (Micrococcus aguis citreus Menge, Cent. B. Bakt., 12, 1892, 52; Planococcus citreus Migula, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 236; Micrococcus aguis-cutreus Chester, Man. of Bact., 1901, 115; Bergey et al., Manual, 1st ed., 1923, 74.) From M. L. citreus, lemon-yellow. Spheres: 0.6 to 0.8 micron, occurring singly, in pairs and in packets. Motile,

possessing a single flagellum. Grampositive.

Gelatin colonies: Small, circular, yellowish, entire, becoming citron-yellow

to orange. Gelatin stab: No liquefaction.

Agar colonies: Small, yellow, conver, entire, smooth, glistening.

Agar slant: Abundant, yellow, plumose, glistening, taking on an orange color with age.

Broth: Turbid.

Potato: Abundant, yellow growth.

Indole not formed.

Nitrites not produced from nitrates Aerobic.

Optimum temperature 25°C.

Habitat: Air.

8. Sarcina littoralis Poulsen. (Poulsen, Vidensk, Meddel. naturh. Foren. i Copenhagen, 1870-80, 231-254; Sarcina morrhuae Farlow, U. S. Fish Commission Report for 1878, 1880, 974, Microcecus a, Høyo, Bergens Museums Anrbog., No. 7, 2 Hefte, 1901, 39; Microccus literalis Kellerman, Cent f. Bakt., II Abt., 42, 1915, 399.) From Latin, litus (littus) -toris, the sea shore; -alix, relating to.

The relationships of the following to each other and to Sarcina littoralis are not clear:

Erythroconis Intoralis Ocrsted. (Naturh. Tidaskritt, 3, 1840–41, 555, Mersmopedia Intoralis Rabenhorst, Flora Europ. Algarum, 2, 1864–65, 57, Sarcina Iltoralis Winter in Rabenhorst, Kryptogamen. Flora, 1, I Abt., 1881, 30, Pediococcus Intoralis Trevisan, 1 generi e le specie delle Batterinece, Milano, 1889, 28; Lampropedia Intoralis De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1049, 1889, 1049.

Coniothecium bertherandi Mégnin (Revue Mycologique, 6, 1881, 197 Saccardo and Berlese (Atti del R Instituto Veneto, Ser. VI, Vol. 3) consider C bertherandi to be identical with Sarcina littoralis, while Zopf (Die Spaltpilze, 2 Aufl., 1881, 73; 3 Aufl., 1885, 102) considers C. bertherandi a stage of Beggatala raseo-persectina.

Description taken from Lochhead (Can

Jour. Res., 10, 1931, 280).

Spheres: 1.2 to 16 microns occurring singly, in pairs, in fours, in short chains, and in packets, the arrangement varying with medium, temperature, salt concentration and age of culture Non-motile Gram stain variable, with rather more positive than negative cells

No growth in ordinary media

Salt gelatin: Growth slow, with no liquefaction,

Starch media (20 per cent salt) · Colonies usually 1 to 3 mm, round, entire, convex, with a waxy appearance, brick red with a pile border, color appearing gradually.

Starch media slants (20 per cent salt): Filhform, slightly raised, entire edge Coral red in color. Slight decrease in shade as cultures age.

Liquid media . No growth

Potato: In 20 per cent salt, scanty growth. Slight chalky pink development near the top. Indole not formed.

Nitrates reduced to nitrites.

Diastatic action negative.

Aerobic, obligate
Halophilic, obligate, 16-32 per cent
salt. Optimum 20-21 per cent.

Optimum temperature 37°C.

Source: Isolated from seashore mud near Copenhagen.

Habitat. Sea water brine, or sea salt. Isolated from salted hides and salted fish.

The following is believed by Kellerman (loc. cit) to be a variety of Sarcina littoralis:

Diplococcus gedidarum Beckwith (Beckwith, Cent f. Bakt., I Abt., Orig., 60, 1911, 331; Micrococcus Intorales gadidarum Kellerman, Cent. f. Bakt., II Abt., 42, 1915, 400; Peducoccus gadidarum Pribram, Klassification der Schiromyceten, 1933, 46) From reddened salted codifish.

9. Sarcina ureae (Beijennok), Cāhnis. (Planosarcina ureae Beijennok, Cent. f. Bakt, II Abt., 7, 1901, 52, Löhnis, Landwirtsch bakteriol Prakticum, 1911, 138; Sporosarcina ureae Kluyver and van Niel, Cent f. Bakt, II Abt., 04, 1936, 401) From Greck, urum, urine, M. L., urea, urea

Probable synonym Sarcina psychrocarterica (Rubentschick) Bergey et al. (Urvosarcina psychrocarterica Rubentschick, Cent f Bakt, II Abt., 64, 1925, 163, ibid, 66, 1926, 161; ibid, 67, 1926, 167, ibid, 68, 1926, 327, Bergey et al., Manual, 3rd ed., 1930, 95)

Spheres 07 to 12 microns, occurring singly, in pairs and in packets Atypical endospores present Motile, possessing long pentrichous flagella. Grampositive. Gelatin colonies. Small, circular, flat,

tough, yellowish.

Converts urea into ammonium car-

Converts urea into ammonium car bonate.

Aerobic.

Optimum temperature 20°C. Resists heating to 80°C for 10 minutes Source: Isolated from urine.

Appendix: The following names appear in the literature, and are listed here chiefly for their historical interest. Many are inadequately described, and probably many are synonyms.

Micrococcus aurantiacus Pagliani, Maggiora and Fratim. (Pagliani et al., 1887; Pediococcus aurantiacus Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 28; Merismopedia aurantiaca Maggioria, Giorn. Soc ital d'Igiene, 11, 1889, 355; Pediococcus maggiorae De Toni and Trevisan, in Saccardo, Syllogo Fungorum, 8, 1889, 1051.) From skin of the human foot.

Plamosarena samesii Migula. (Eine bewegliche Sarcine, Sames, Cent. f. Bakt., 11 Abt., 4, 1898, 661; Migula, Syst. d. Bakt., 2, 1900, V and 278; Sarcina agilis Matzuschita, Zeit. f. Hyg., 35, 1900, 496) From liquid manure. Probably identical with Sarcina ureae Lohnis.

Sarcina acidificans Migula. (Sarcina No VIII, Adametz, Landwirtsch. Jahrb., 18, 1889, 243; Migula, Syst. d. Bakr., 1900, 258) From cheese. Winslow and Winslow (The Systematic Relationships of the Coccaccae, 1909, 235) regard this species as a variant of Sarcina lutea Schroeter.

Sarcina agilis Saito (Jour. Coll. Science Imp. Univ. Tokyo, 23, 1908, 68; abst in Cent. f. Bakt, II Abt., 24, 1909, 228) From dust.

Sareina alba Zimmermann (Weisse Sareina, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, 1887, 64, Zimmermann, Die Bakterien unserer Trinku. Nutzwasser, Chemnitz, I Reihe, 1890, 90.) From water. Zimmermann reported the presence of spores; subsequent workers failed to observe spores, even when working with original cultures.

Sarana alba var. incana Appel. (Ber. d. landw. Inst. Konigsberg, Heft 5, 1900, 89; quoted from Lohnis, Cent. f. Bakt., II Abt., 18, 1907, 146) Frequently found in milk Closely related to Adametz's Sarcinae Nos VII, VIII and IX.
Sarana albada Gruber. (Arb. bkt.

Sarcina albida Gruber (Arb. bakt. Inst. Karlsruhe, 1, Heft 3, 1895, 256) Fröm the stomach contents of a man with stomach cancer. Sarcina alutacea Gruber (loc. cit., 221). From leaven.

Sarcina aurea Macé. (Traité Pratique de Bact., 2nd ed., 1892, 371; not Sarcina aurea Henrici, see below.) From lung exudate. Possesses active oscillary motility, but no flagella.

Sarcina aurea Henrici. (Arb. bak. Inst. Karlsruhe, 1, Heft 1, 1894, 91; Sarcina aurescens Gruber, ibid., Heft 3, 1895, 203.) From Swiss cheese. Winstow and Winslow (loc. cit., 233) regard this species as a variant of Sarcina flace De Bary which has acquired certain formentative powers.

Sarcina aurescens var. mucosa Jaiser; quoted from Pribram, Klassifikation der Schizomyceten, 1933, 44.

Sarcina bicolor Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1897, 505.) From the stomach of a woodpecker (Picus major). Winslow and Winslow (loc. cit., 232) regard this species as identical with

Sarcina flava De Bary.
Sarcina butyrica Migula. (Sarcina No.
XI, Adametz, Landwirtsch. Jahrb., 18,
1889, 214; Migula, Syst. d. Bakt., 8, 1900.
210.) From cheese. Winslow and Winslow (loc. cit., 233) regard this as a variant
of Sarcina flava De Bary which has acquired certain fermentative powers.

Sarcina candida Lindner. (Die Sarcina-Organismen der Gährungsenerbe, Inaug. Diss, Berlin, 1888, 43; Abst. in Cent. f. Bakt., 4, 1888, 427.) From water reservoir of a brewery and from air in the vicinity of the brewery.

Sarcina canescens Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 143.) Stubenrath considered this a subspecies or variety of his Sarcina equi from which it differed only by its constant gray color on all culture media. Winslow and Winslow (loc. cit., 232) regard this as identical with Sarcina flata De Bary.

identical with Sarcina flata De Bary. Sarcina carnea Gruber. (Arb. bakt Inst Karlsruhe, 1, Heft 3, 1895, 278)

From leaven.

Sarcina casei Migula. (Sarcina No. VII, Adametz, Landwirtsch. Jahrb., 18,

1889, 242; Migula, Syst. d. Bakt. 2, 1900. 239.) From cheese Winslow and Wans. low (loc. cit., 233) repard this species as a variant of Sarcina flava De Bary which acquired certain fermentative DOWERS

Sarcina cascolutica Stark and Scheib. (Jour. Dairy Sci., 19, 1936, 212 ) hutter

Sarcina cervina Stubenrath (Stuben. rath, in Lehmann and Neumann, Bakt, Diag., 1 Aufl., 2, 1896, 146 ) From the stomach in a case of careinoma

Sarcina citrea Winslow and Winslow (The Systematic Relationships of the Coccacceae, 1908, 231; not Sarcina citrea Bergey et al., Manual, 1st ed . 1923, 74 ) This is the name given by Winslow and Winslow to their Type 2, the intratereducing group of Sarcina.

Sarcina citrina Gruber (Arb bakt Inst. Karlsruhe, 1, Heft 3, 1895, 269 From leaven, Winslow and Winslow (loc. cit., 235) regard this species as identical with Sarcina lutea Schroeter

Sercina conjunctuae Bergey et al (Sarcina citrea conjunctivae Verderame, Cent f. Bakt . I Abt .. Orig , 59, 1911, 384; Bergey et al., Manual, 1st ed , 1923, 71.) From the conjunctiva Gramnegative.

Sarcina devorans Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 502) From stomach contents of a sparrow (Passer montanus).

Sarcina equi Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt Diag., 1 Aufl., 2, 1896, 143.) Found frequently in the urine of horses. Very similar to Sarcina lutea according to Stubenrath, who names three subspecies or varieties; Sarcina livido-lutescens, S. canescens and S. variabilis. Winslow and Winslow (loc cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina erythromyza (Overbeck) Král. (Micrococcus erythromyza Overbeck, Nova Acta der Leop.-Carol, 65, No. 7, 1891; Král, Verzeichnis der abzugebenden Bak.) For a description of this species, see Zimmermann. Die Bakterien unserer Trink- und Nutzwässer, Chemnitz, II. 1894, 70. From water. Produces a red nittnent

Sorcina fimentaria Lehmann and Neumann. (Eine bewegliche Sareine Sames Cent. f. Bakt . II Abt., 4, 1898, 661; Lehmann and Neumann, Bakt, Diag. 2 Aufl . 2. 1899. 146. Planosarcina samesis Migula, Syst. d. Bakt . 2, 1900, V and 278: Sareina samesti Matzuschita, Bakt. Diag., Jena. 1902, 300.) From hould manure. Exhibits active motility with many long flagella. Prihram (Klassifikation der Schizomyceten, 1933, 45) reeards this organism as identical with Saterna ureae and Sarcina mobile

Sarcina flavescens Henrici bakt Inst. Karlsrube, 1, Heft 1, 1894. 91 ) From Swiss cheese Winslow and Winslow (loc cit , 232) regard this species as identical with Sarcina flava De Bary.

Sarcina fulva Stubenrath. Genus Sarcina, Munchen, 1897; see Lehmann and Neumann, Bakt Diag , 2 Aufl. 2, 1899, 143.) Isolated many times from stomach contents and once from preputial smegma. Similar to Sarcina milmonum.

Sarcina fusca Gruber (Arb. bakt, Inst. Karlsruhe, 1, Heft 3, 1895, 282.) From flour

Sarcina fuscescens De Barv (Vorlesungen über Bakterien, 2 Aufl., 1887, 181 and Botan Centralb., 1887, 34 Reduced to a synonym of Sarcina ventriculi Goodsir by Migula, Syst. d. Bakt , 2, 1900, 259 ) From the contents of the stomach.

Sarcina gasoformans Gruber. (Arb. bakt Inst Karlsruhe, 1, Heft 3, 1895. 270 ) From leaven Young cultures produce considerable gas

Sarcina gigantea Kern (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 508) From stomach contents of the starling (Sturnus tulgaris). The diameter of a cell is 2 05 to 2.1 microns. Winslow and Winslow (loc cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina gigantea Petter (Proc. Kon.

Akad. Wet. Amsterdam, \$4, 1931, 1417; Thesis, Utrecht, 1932; Compt. rend. Acad. Sci, Paris, 196, 1933, 300.) From salted herring. Halophilic.

Sarcina hamaguchiae Saito. (Cent. f. Bakt., II Abt., 17, 1906, 155.) From

soy bean mash.

Sarcina incana Gruber (loc. cit., 248). From leaven.

Sarcina incarnata Gruber. (Loc. cit., 279; Rhodococcus incarnatus Winslow and Rogers, Jour Inf. Dis., 5, 1906, 545.) From leaven. Produces pink pigment.

Sarcina intermedia Gruber (Loc. cit., 277). From leaven. Winslow and Winslow (loc. cit., 235) regard this species as identical with Sarcina lutea Schroeter.

Sarcina intestinalis Zopf. (Die Spaltpilze, 3 Aufl., 1885, 55.) From the intestines of poultry

Sarcina lactea Gruber. (Loc. cit., 254; not Sarcina lactea Bergey et al., Manual, 1st ed., 1923, 73.) From leaven.

Sarcina lactis Chester. (No 45, Conn, Storrs Agr. Exp Sta. Rept, 1894, 79; Chester, Man. Determ. Bact., 1901, 111.) From fermented milk (matzoon). Winslow and Winslow (loc. ci, 232) regard this species as identical with Sarcina flava De Bary.

Sarcina lactis acidi Conn, Esten and Stocking. (Storrs Agr. Evp. Sta. Ann. Rept., 1907, 125.) From milk.

Sarcina lactis albus Conn, Esten and Stocking (loc. cit., 121). From milk.

Sarcina lactis aurantiaca Conn, Esten and Stocking (loc. cit., 125). From milk.

Sarcina lactis lutea Conn, Esten and Stocking (loc. cit , 124). From milk.

Sarcina lemble: Migula (No. 24, Lembke, Arch. f. Hyg., £6, 1896, 316; Migula, Syst. d. Bakt., £, 1800, 21t.) From the intestine. Winslow and Winslow (loc. cit., 232) regard this species as identical with Sarcina flava De Bary.

Sarcina liquefaciens Frankland and Frankland. (Phil. Trans. Royal Soc. London, 178, B, 1888, 267.) From dust. Also found in cheese by Henrici (Arb., bakt. Inst. Karlsruhe, I, Hett I, 1889, 95). Winslow and Winslow (loc. cit, 322) regard this species as identical with Sarcina flare De Bary.

Sarcina luvida Gruber (loc. cit., 227). From leaven. Winslow and Winslow (loc. cit., 235) regard this species as identical with Sarcina lutea Schroeter Sarcina livido-lutescens Stubenrath. (Stubenrath, in Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 143; Sarrina Lutescens Chester, Man. Determ. Bact., 1901, 112.) From stools in a case of enteritis. Stubenrath regards this as a subspecies or variety of his Sarcina caux.

Sarcina loewenbergi: Macé. (Une sarcine pathogène, Loewenberg, Ann. Inst. Past., 15, 1899, 385; Macé, Traité Pratique de Bact., 4th ed., 1901, 461.) From the masal cavity in a case of erem. Probably a strongly slime-forming variety of Sarcina tetragena, according to Lehmann and Neumann, Bakt. Dag. 3 Aufl., 2, 1912, 206. Also see Galla-Valerio, Cent. f. Bakt., 1 Abt., Orig., 47, 1903, 177, for discussion.

Sarcina luteola Gruber (loc. cit., 265). From leaven. Winslow and Winslow (loc. cit., 235) regard this species 88 identical with Sarcina lutea Schroeter Sarcina marginata Gruber (loc. cit.,

208). From leaven. Winslow and Winslow (loc. cit., 235) regard this as identical with Sarcina lutea Schroeter.

Sarcina melifara Gruber (loc. cit, 272). From flour. Winslow and Winslow (loc. cit., 235) consider this identical with Sarcina lutea Schroeter.

Sarcina minuta De Bary. (Vorlesunzen über Bakterien, 1 Aufl., 1885; Engtrans., 2nd ed., 1887, 117 and 185.)

Sarcina mirabilis Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft. 4, 1897, 683) From intestine of the yellow-hammer (Emberica citrinella) and a dove (Columba cenas). Winslow and Winslow (Icc. cit., 232) consider this species identical with Sarcina flava De Bary.

Bakt., II Abt., 61, 1925, 495; Pribram, Klassifikation der Schizomyceten, 1933, 45.) Lives symbiotically with cockroaches.

Sarcina thermodurica Wainess and Parfitt. (Jour. Bact., 40, 1940, 157.) From milking machines and other dairy farm utensils. Resists pasteurization temperatures

Sarcina thermophila Bargagli-Petrucci. (Nuov. Giorn Bot Ital., 20, 1913; Abst. in Cent f. Bakt., II Abst., 43, 1915, 294) From the borax-yielding waters of Tuscany. Grows at temperatures up to 75°C.

Sarcina urinae Welcker (Sarcina renis Hepworth, Microscop Jour., 6, 1857, 1; Welcker, in Henle and Pfeffer, Ztschr f. rat Med, 3 Ser, 6, 1859, 199; Merismopedia urinae Rabenhorst, Flor. europ. algarum, 2, 1865, 59.) Observed in the bladder See below. Sarcina welcker

Sarcina variabilis Stubeniath (Stubenrath, in Lehmann and Neumann, Bakt Diag, 1 Aufl, 2, 1896, 143) From gastric contents May be considered a subspecies of Sarcina equi Stubenrath Winslow and Winslow (loc cit., 232) regard this as identical with Sarcina flava De Bary.

Sarcina variegata Pansini. (Arch f. path. Anat., 122, 1890, 450.) Found in sputum from cases of influence.

Sarcina velutina Gruber (loc. cit, 275). From leaven. Winslow and Winslow (loc. cit., 235) consider this species identical with Sarcina lutea Schroeter Sarcina vermicularis Gruber (loc cit,

253), From wheat flour.

Sarcina vermiformie Gruber (lec. cit., 266). From leaven. Winslow and Winslow and winslow (lec eit., 235) consider this species identical with Sarcina lutea Schnotter. Sarcina viridis flavescens Rosenthal (Inaug. Diss., Erlangen, 1893; Abst. in Cent. f. Bakt., 16, 1894, 1024.) From the oral cavity.

Sarcina welckeri Rossmann. (Rossman, Ueber Urinsarcina, Flora, 40, 1857, 641; Merismopedia welckeri Rabenhorst, Flora europaea, Alg. II, 1865, 58) From the urinary bladder

Urosarcina dimorpha Beijerinch. (Cent. f. Bakt., II Abt., 7, 1901, 53) Reported to form spores. Non-motile. From garden earth.



- Chromogenesis best seen on Löffler's serum.
  - Acid from fructose. b. Acid from sucrose
    - bb. No acid from sucrose.
- 5 Neisseria perflava.
  - 6. Neisseria flava. aa. No acid from fructose.
    - b. Acid from glucose,

      - bb. No acid from glucose.

### II. Anaerobes.

- A. Gas produced from peptone broth.
- B. No gas produced.
  - 1. Odor of rancid butter.
  - 2. No rancid odor.
- 11. Neisscria orbiculata.
- Neisseria gonorrhoeae Trevisan. (Micrococcus der Gonorrhoe, Neisser, Vorl. Mitteil , Cent. f. Medicinische Wissenschaft, 17, 1879, 497; Trevisan, Atti della Accademia Fisio-Medico-Statistica in Milano, Ser 4, 3, 1885, 105.) From Greek, gonorrhoea, flux of semen; M.L. genitive of gonorrhoea

Synonyms: Gonococcus, Diplococcus der Gonorrhoe, Bumm, Der Mikroorganismen der gonorrhoischen Schleimhauterkrankung, Weisbaden, 1885, 16; Merismopedia gonorrhoeae Zopf, Die Spaltpilze. 1885. 54; Micrococcus gonorrhoeae Flugge, Die Mikroorganismen, 1886, 156; Micrococcus gonococcus Schroeter, in Cohn, Kryptog Flora v. Schlesien, S, I, 1886, 147, Diplococcus gonorrhocae Lehmann and Neumann, Bakt Diag , 1 Aufl., 2, 1896, 150, Micrococcus gonorrhocae Lehmann and Neumann, ibid., 4 Aufl., 2, 1907, 212.

Spheres: 06 to 1.0 micron, occurring singly and in pairs, the sides flattened where they are in contact. Gramnegative

Grows only on media with the addition of body fluids (blood, ascites, etc.), or other specially prepared media.

Colonies are small, transparent, even-

7. Neisseria subflava.

8. Neisseria flavescens. Neisseria discoides.

- 10. Neisseria reniformis.

tually (2 to 4 days) developing a lobate margin, grayish-white with a pearly opalescence by transmitted light. Larger colonies on special media.

Acid from glucose. No acid from maltose, fructose, sucrose and mannitel Optimum temperature 37°C.

growth below 25° or above 40°C. Aerobic to facultative anacrobic. Many strains develop more readily with increased CO: tension.

Common name: Gonococcus.

Source: Originally found in purulent venercal discharges. Also found in blood, conjunctiva, joints and cerebrospinal fluid.

Habitat: The cause of gonorrhoea and other infections of man. Not found in other animals.

2. Neisseria meningitidis (Albrecht and Ghon) Holland. (Diplokokkus intracellularis meningitidis Weichselbaum, Fortschr. d. Med., 5, 1887, 583; Neisseria weichselbaumii Trevisan, I generi e le specie delle Batteriacce, 1889, 32; not Diplococcus intracellularis Jacger, Ztschr. f. Hyg., 19, 1895, 353; not Telracoccus intracellularis Jaeger, sbid., 368; pot Streptococcus intracellularis Lehmann

1896. 132; Micrococcus intracellularis Migula, Syst. d Bakt., 2, 1900, 189, Mercenceus meningococcus cerebrospinalis Albrecht and Ghon, Wiener Llin Wochnschr., 14, 1901, 988, not Streptococcus weichselbaum: Chester. Man. Determ. Bact., 1901, 64, not Meningococcus intracellularis Jacger, Cent. f Bakt., I Abt., Orig., \$5, 1903. 23, Micrococcus meningitidis Albrecht and Ghon. Cent. f. Bakt., I Abt , Orig , 55, 1903, 198: Diplococcus intracellularis Weichselbaum, Cent. f. Bakt., I Abt , Orig , 55, 1903, 511; Micrococcus intracellularis meningitidis de Bettencourt and Franca. Ztschr. f. Hvg., 46, 1901, 461, Diplococcus meningitidis, ibid., 495; Holland, Jour Bact., 5, 1920, 224: Newseria intracel lularis-meningitidis Holland. ibid . 221. Neisseria intracellularis Holland, ibid . 221, sec also Elser and Huntoon, Jour Med. Res . 20 (N. S. 15), 1909, 371 and Murray, Med. Res. Council, London, Special Report Series No. 124, 1929 for detailed studies of the group ) From Greek, meninz, meninges, a membrane, a membrane covering the brain; M L genitive of meningitis, an inflammation of the meninges.

and Neumann, Bakt. Diag., 1 Aufl., 2,

The binomial, Neisseria intracellularis, used in previous editions of the Manual has proved confusing because the names Micrococcus intraccllularis, Diplococcus intracellularis and Streptococcus intracellularis, have been used loosely for unrelated organisms. Neisseria ueichsel baumii has been so rarely and loosely used that any attempt to introduce it now is inadvisable despite rights of priority. The equally available name, Neisseria meningitidis, has therefore been adopted to avoid further confusion It has the obvious advantage of association with the common name, meningococcus, which has been so frequently used in the literature.

In 1898, Councilman, Mallory and Wright (Epidemic Cerebrospinal Meningits and its Relation to Other Forms of Meningitis, Boston, 1898) definitely established the Gram-negative occus as the cause of epidemic meningitis and clarified the confusion created because Jaeger regarded the occus that he isolated (see Diplococcus crassus von Lingelsheim) as identical with Nesserra meningitatis.

Spheres: 0 6 to 0 8 micron in diameter, occasionally larger, occurring singly, in pairs with adjacent sides flattened, or occasionally in tetrads. Gram-negative.

Good growth is obtained on media containing blood, blood scrum and other correlment fluids with added glucose. Best growth on special media

Blood agar plates are generally employed to isolate the organism. The colonies are small, slightly convex, transparent, glistening Colonies large on special media.

Older cultures may show growth on neutral agar or glucose agar, properly prepared Frequent transplantation is necessary to keep the organism alive in recently isolated strains, older strains survive for one month or longer at 37°C and for years on special media

Acid from glucose and maltose No acid from fructose, sucrose and mannitol. Nitrites not produced from nitrates (Branham)

Optimum temperature 37°C No growth at 22° or at 40°C

Aerobic, no growth anaerobically Common name. Meningococcus

Common name. Meningococcus Source: Originally found in cerebro-

spinal fluid Also found in nasopharynx, blood, conjunctiva, pus from joints, petechiae in skin, etc

Habitat Nasopharynx of man, not found in other animals Cause of epidemic cerebrospinal fever (meningitis).

Four main varieties or types of Neisseria meningitidis have been differentiated by Gordon and Murray (Jour. Roy Army Med. Corps, 25 (2), 1915, 423) and by others on the basis of agglutination reactions with minune serums  Neisseria catarrhalis (Frosch and Kolle) Holland. (Micrococcus catarrhalis Frosch and Kolle, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 161, Diplococcus pharyngis communis von Lingelsheim, Klin. Jahrb., 16, 1900, 242.)
 Bact., 5, 1920, 221.)
 From Greek, catarrh, a running down.

Spheres: 0 6 to 0.8 micron in diameter, occurring singly or in pairs with adjacent sides flattened, occasionally in fours.

Gram-negative.

Agar colonies: Small, circular, grayish white to dirty white, with crose margins Broth: Turbid, often with slight pellicle.

No acid from any of the carbohydrates. Optimum temperature 37°C. Grows well at 22°C.

Aerobie, facultative.

Source: Nasopharyny, saliva and respiratory tract.

Habitat: Human mucous membrane of the respiratory tract. Often associated with other organisms in inflammations of the mucous membrane

Note: Topley and Wilson (Prin. of Bact., 1931, 349) state that Nesseria pharyngis cinerea (Microcaccus pharyngis cinereus von Lingelsheim, Klin Jahrb., 15, 1906, 373) resembles Nesseria catarrhalis so closely that it should probably be regarded as a variety of this species.

4. Nelsseria sicca (von Lingelsheim)
Bergey et al. (Drplococcus pharyngis
siccus von Lingelsheim, Klin Jahrb., 15,
1906, 409; Diplococcus siccus von Lingelsheim, Ztschr f Hyg., 59, 1938, 476;
Micrococcus pharyngis siccus Kutscher,
in Kolle and Wassermann, Handb. d.
Path Mikroorganismen, 2 Aufl., 4, 1912,
603; Micrococcus pharyngis-siccus Holland, Jour of Bact., 5, 1920, 224; Neisseria pharyngis-sicci (sic) Holland, ibid.;
Bergey et al., Manual, 1st ed., 1923, 43)
From Latin, sicca, dry.

Spheres: 0 6 to 0 8 micron in diameter, occurring singly and in pairs with adjacent sides flattened Gram-negative. Blood agar colonies: Grayish, somewhat dry, crumbling when an effort is made to remove them.

Ascitic agar colonies: Small, very firm and adherent to medium, becoming corrugated on the surface.

The organisms precipitate spontaneously when suspended in normal salt solution.

Acid from glucose, fructose, maltose and sucrose. No acid from mannitol Optimum temperature 37°C. Grows

at 22°C. Aerobic, facultative.

Source: Nasopharynx, saliva and spuum.

Habitat: Mucous membrane of the respiratory tract of man.

 Neisseria perflava Bergey et sl (Chemogenic group I, Elser and Hustoon, Jour. Med. Res., 20 (N. S. 18), 1909, 415; Bergey et al., Manual, 1st ed., 1923, 43.) From Latin per, very and flavus, yellow.

Spheres: 0.6 to 0.8 micron, occurring singly and in pairs with adjacent sides

flattened. Gram-negative.

Glucose agar colonies: Small, circular, slightly mised, greenish-gray by reflected light, and greenish-yellow and semi-opaque by transmitted light. The surface is smooth, glistening. The growth is adherent to the medium. Chromogenesis best seen on Löffler's blood serum medium.

Ascitic agar colonies: Like those on

glucose agar.

Acid from glucose, maltose, fructose, sucrose and mannitol.

Optimum temperature 37°C. Grows at 22°C.

Aerobie, facultative.

Source: Nasopharyny, saliva and sputum.

Habitat: Mucous membrane of respiratory tract of man.

 Neisseria flava Bergey et al. (Diplococcus pharyngis flavus I and possibly Diplococcus pharyngis flauss II, von Lingelsheim, Klin. Jahrb., 15, 1906, 403, Drplococcus flauss I and possibly Drplococcus flauss II, v. Lingelsheim, Zettschr. f. Hyg., 63, 1908, 476, Mercoccus pharyngis flauss II, Lehmann and Neumann, Bakt. Ding., 7 Aufl., 2, 1927, 239; Chromogenie group II, Liser and Iluntoon, Jour. Med. Res., 20 (N S 15), 1909, 415; Bergey et al., Manual, 1st ed. 1923, 43 | From Latin flaus vellow.

Spheres: 0.5 to 0.8 micron, occurring singly and in pairs with advacent sides

flattened. Gram-negative

Glucose agar colonies: Small, circular, alightly raised, greenish-grlow by transmitted light and greenish-yellow by transmitted light. Growth not adherent to medium Surface colony is smooth with numerous, rather coarse crumbs in center. Margin entire, or rarely slightly irregular Chromogenesis best seen on Loffler's blood serum medium.

Ascitic agar colonies: Like those on

glucose agar.

Acid from glucose, fructose and maltose. No acid from sucrose or mannitol

Optimum temperature 37°C. Grows

tory tract.

at 22°C.
Source: Nasopharynx, cerebro-spinal

fluid in cases of meningitis (very rare). Habitat: Mucous membrane of respira-

 Nelsseria subflava Bergey et al (Chromogenic group III, Elser and Huntoon, Jour. Med. Research, 20 (N.S. 15), 1902, 415, Bergey et al., Manual, 1st ed., 1923, 44) From Latin sub, less and flavus, yellow.

Spheres: 06 to 08 micron, occurring singly and in pairs with adjacent sides flattened. Gram-negative

Glucose agar colonies Small, slightly raised, pale greenish-yellow, especially on primary culture.

Acid from glucose and maltose No acid from fructose, sucrose or mannitol.

Agglutinates in normal rabbit serum.
Optimum temperature 37°C. Little
or no grow that 22°C.
Aerobic, facultative

Easily confused with Neisseria men-

Source · Nasopharyny.

Habitat. Mucous membrane of the respiratory tract of man

8 Neisseria flavescens Branham (U S Public Health Service, Pub. Health Repts., 45, 1930, 845) From Latin flatescens, becoming yellow.

Biscuit-shaped cocci occurring in flattened pairs. Giant forms common.

Gram-negative.

Glucose agar. Poor growth Blood agar: Good growth, colonies less moist than those of the meningococcus. Golden yellon pigment. Greenish-yel-

low on Loffler's blood scrum medium. Semisolid agar. Good growth

No acid from any of the carbohydrates Optimum temperature 37°C.

Acrobic, facultative

Serologically homogeneous group Source Cerebro-spinal fluid in cases of menuncitis.

Habitat Probably mucous membrane of respiratory tract of man.

Norz: Wilson and Smith (Jour. Path and Bact, 31, 1923, 597) do not regard differences in sugar fermentations, chromogenesis, appearance of colonies, etc sufficiently constant to warrant the separation of the species Nesseria catarrhalis, N flaca, N cincrea, N mucosa and N sicca They recommend that all be grouped under a single species known as Nesseria pharyngis (Diplococcus pharyngis).

 Neisseria discoides Prévot (Ann. Sei Nat., Sér Bot., 15, 1933, 106)
 From Groek, discoeides, discus shaped;
 Latin adj., disk-shaped.

Spheres: 0.6 to 0.7 micron, occurring in pairs or tetrads Gram-negative.

Gelatin: No liquefaction.

Deep agar colonies: Lenticular, up to 1 mm in diameter Grows in a narrow disk about 1 cm below the surface. Gas produced

Broth Turbid. Fine granular precipitate. Slight rancid odor and inflammable, explosive gas produced.

Peptone water: Gas produced Indole not formed.

No action on milk.

Considered mark.

Coagulated proteins not digested. Carbohydrates not attacked.

Hydrogen sulfide not produced.

Neutral red glucose broth: Becomes pink, but no further change.

Optimum pH 70 to 80.

Temperature relations Optimum 37°C. No growth at 28°C. Killed in half an hour at 60°C.

Non-pathogenic

Strict anaerobe.

Distinctive characters Colonics grow in narrow zone 1 cm below the surface of an agar stab; gas produced from peptones.

Source: Isolated from bronchial mucus, respiratory system, dental and tonsillary focal infections.

Habitat: Buccal cavity (human) and probably also in other warm-blooded animals.

10. Nelsserla realformis (Cottet) Prévot. (Diplococcus reniformis Cottet, Compt rend. Soe Biol, 52, 1900, 421; Micrococcus reniformis Oliver and Wherry, Jour. Inf. Dis., 28, 1921, 341; Prévot, Ann. Sci. Nat., 56r. Bot., 15, 1933, 102.) From Latin, ren (renes), kidney; -formis, form, i.e. kidney-shaped.

Spheres: 0.8 to 1.0 micron, bean-shaped, occurring in pairs Gram-negative Gelatin: No liquefaction.

Gelatin: No liquelaction,

Deep agar colonies: Appear in 24 to 48 hours; at first punctiform, then lenticular; small, 03 to 0.5 mm. No gas produced.

Agar slant: Minute, bluish-white, dewdrop colonies. Broth: Turbid in 24 hours; flocculent precipitate rapidly formed, clearing the medium. No gas produced, but a rancid odor is present.

Peptone water: Very meagre growth. Traces of indole.

Milk: Unchanged.

Coagulated proteins not digested.

Slight amount of acid from glucose by one strain only.

Optimum pH 7.0. Limits of pH 60 o 8.0.

Temperature relations: Optimum 37°C.

No growth at 22°C. Killed in half an hour at 60°C. or in an hour at 56°C

Pathogenic.

Strict anaerobe,

warm-blooded animals.

Distinctive character: Odor of rancid butter.

Source: Isolated in several cases from suppurations of the urino-genital system Habitat: Presumably in bodies of

11. Neisseria orbiculata Prévot. (Dilococcus orbiculus Tissier, Ann. Inst. Past., 22, 1908, 204; Prévot, Ann. Sci Nat., Sér Bot., 15, 1933, 100.) From Latin, orbiculatus, having the form of an orb or subere.

Spheres: 1.5 to 2.0 microns, occurring in pairs. Gram-negative.

Gelatin: No growth at 22°C.

Deep agar colonies: After 36 to 48 hours, large, lenticular, very regular, whitish, almost transparent. Gas not produced Broth: Turbid. Sediment.

Milk: No coagulation.

Egg white not attacked.

Proteoses attacked without formation

of indole.

Acid from glucose. Acid produced feebly from lactose. No acid from su-

crose.
Temperature relations: Optimum 37°C.

No growth at 22°C. Killed at 60°C.

Non-pathogenic.

Strict anaerobe.

Distinctive characters: Large asse; no gas production

Source: Isolated from feces of young

Habitat: Intestinal canal Not common.

Appendix I: Additional species have been placed in this genus as given below Some are undoubtedly identical with previously described species, while some may belong in other genera

Diplococus crassus von Lingelsheim (Diplococus intracellularis Jacger, Zlesh, f. Hyg., 19, 1893, 333, Tetracoccus intracellularis, ibul, 318, von Lingelsheim, Zleshr, f. Hyg., 59, 1903, 467, Micrococcus crassus Lehinann and Neumann, Bakt. Ding., 7 Aufl, 2, 1927, 259). Commonly found in masophizyngal secretions, also in the cerebrospinal fluid of suspected cases of meningitis. Also known as Jacger's occus or as Jacgersher Modifikation der Meningococcus.

Diplococcus mucosus von Lingelsheim (von Lingelsheim, Klin, Jahrb., 15, 1906, 373, and Ztschr. f. Hyg. 59, 1908, 457, Neisseria mucosa Murray, in Manual, 5th ed., 1939, 283, not Streptococcus mucosus Howard and Perkins, Jour Med Res, 6, (N S 1), 1901, 174, not Pneumococcus mucosus Park and Williams, Jour Exp. Med., 7, 1905, 411.) From pasal secretions This Gram-negative coccus is said to show similarity to the meningococcus and to be like the diplococcus found by Weichselbaum and Ghon (Weiner Klin Wehnschr , No 21, 1905) in nasal secretions of a healthy person. Clearly it is different from the Gram positive, mucoid type of pneumococcus which is described by Binaghi (Cent f. Bakt, I Abt., 23, 1897, 273), Howard and Perkins (Jour Med. Res , 6, 1901, 174), Park and Williams (Jour. Exp. Med., 7, 1905, 411) and others

Micrococcus pharyngis cinereus von Lingelsheim. (Klin. Jahrb., 15, 1906, 373; Micrococcus cinereus v Lingelsheim. Ztschr. f. Hyg., 59, 1903, 456, Neusseria cinerea Murray, in Manual, 5th ed., 1939, 283 ) From mucous membrane of nose and threat

Neisseria arthritica (Costa) Hauduroy et al (Microceccis arthritica Costa, Comp rend, Soc. Biol., Paris, 85, 1920, 933, Handuroy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire des Bactères Pathogènes, Paris, 1937, 296) Isolated from a case of human arthritis Neisseria chulon, (sic.) Trevision.

Neisseria cdigloni (sic) Trevisan, Opplecoccus scarlatinae sanguinis Jamieson and Edington, Brit. Med. Jour., 1, 1887, 1265, Trevisan, I generi e le specie delle Batteriacce, 1889, 32) From a scarlet feyer patient

Neisseria fulia De Bord. (Jour Bact., 53, 1939, 119, Iowa State Coll. Jour Sci., 16, 1942, 471) From conjunctivitis and variaties

Neuseria gibbonsi Hauduroy et al. (Gr.m.-negative coccus, Gibbons, Jour. Inf. Dis., 45, 1929, 299; Hauduroy et al., Diet d Baet Path., 1937, 300) Isolated from skin abscesses in rabbits and guinea. Bus.

Neisseria gigantea De Bord (Jour. Bact, 58, 1939, 119; Iowa State Coll. Jour Sci, 16, 1942, 472) From a normal vacina

Netsseria luciliarum Brown (Amer. Mus Novit, No 251, 1927, 3) A motile, Gram-negative diplooccus that probably should be placed in the genus Micrococcus From a dead fly, Lucilia sericata killed by Bacillus lutica.

Nesseria pseudocatarrhalis Huntoon. (Jour Bact, 87, 1934, 198) Like Netsseria catarrhalis, shons no action on carbohydrates but is culturally more like Nesseria meningitais and forms homogeneous suspensions in a salt solution. From masopharynx

Neisseria rebellis Trevisan. (Micrococcus in Trachoma folliculare, Kucharksky, 1887, Trevisan, I generi e le specie delle Batteriacec, Milan, 1889, 32) From trachoma

Neisseria renezuelensis Hauduroy et al (Riguez, Gaceta Med. de Caracas,

June 30, 1935; Pedro del Corral, Rev. de Med. v Cir. de la Clinica Macacay, April. 1935; Hauduroy et al., Diet, d. Bact,

Path., 1937, 308.) Found in localized epidemics of cerebrospinal meningitis in Venezuela

## Genus II. Veilionella Précot.\*

(Ann. Sci. Nat., Sér. Bot , 15, 1933, 118.) Named for A. Veillon, the French bacteriologist, who isolated the type species.

Small, Gram-negative cocci averaging 0.3 micron. Occur in masses, rarely in pairs or short chains. Cells undifferentiated. United by an interstitial substance of ectoplasmic nature. The known species are anaerobic. Good growth on standard culture media. Biochemical activity pronounced. Harmless parasites in mouth and intestine of man and animals.

The type species is Veillonella parvula (Veillon and Zuber) Prévot.

### Key to the species of genus Veillonella.

I. Acid and gas from glucose. Weakly hemolytic.

1. Veillonella parvula. II. Carbohydrates not attacked. Gas produced from peptone broth. Nonhemolytic.

 Vellionella parvula (Veillon and Zuber) Prévot (Staphylococcus parvulus Veillon and Zuber, Arch. med Exp., 1898, 542, Micrococcus parvulus Bergey et al , Manual, 3rd ed , 1930, 92, Prévot, Ann. Sci Nat . Sér Bot . 15, 1933, 119 ) From Latin, parvulus, very small.

Description from Prévot (loc cit.). Very small spheres. 0 2 to 0.1 micron, occurring in masses, occasionally in very short chains Gram-negative

Gelatin: No liquefaction

Semisolid agar (Veillon) colonies: At first punctiform, becoming lenticular, reaching a diameter of 2 mm Gas bubbles.

Blood agar colonies Usually surrounded by a clear halo; weakly hemolytic. Agar slant . Transparent, bluish, min-

ute colonies.

Peptone broth: Turbid with fine sedi-

Glucose broth: Turbid. Faintly fetid odor. Gas produced contains CO2, II2 and H2S.

Broth serum: Very abundant, rapid growth.

# 2. Veillonella gazogenes.

Milk: No acid. Not congulated. Some strains produce gas.

Small amount of indole formed. Nitrites produced from nitrates. Acid and gas from glucose. Slight amount of acid from fructose, galactose and sucrose. Some strains feebly attack

mannitol, maltose and inulin. Congulated protein not attacked. Ammonia not produced.

Hydrogen sulfide produced. Optimum pH 6.5 to 8.0.

Temperature relations: Optimum 37°C. Grows feebly at 22°C. Killed in one hour at 55°C.

Strict anaerobe.

Distinctive characters: Fermentation of polypeptids to produce hydrogen, carbon dioxide, hydrogen sulfide and indole; fermentation of sugars; hemolysis of blood; production of nitrites from nitrates.

Source: Isolated by Veillon and Zuber from appendices, buccal cavities and lungs. Of the 13 strains studied by Prévot, 3 were isolated from pulmonary gangrene, one from an appendix, one

\* Revised by Prof. E. G. D. Murray, McGill University, Montreal, P. Q, Canada, June, 1938. Descriptions reviewed by Dr. Ivan C. Hall, New York City, January, 1944.

from alveolar pyorthea. 5 from amniotic fluid, 2 from abscesses and pulmonary congestion and one from the buccel cavity of a normal rabbut. Found in suppurative legions or pus. It may orcasionally be notherence and invade the tissues, causing suppurations alone or in association with other progenic organieme

Habitat: Normally a harmless parasite found in natural cavities of man and animals, especially the month and directive tract

1a. Veillonella parvula var minima Prévot. (Staphylococcus minimus Gioelli, Boll, R. Accad. Med. di Genova. 1907; Abst. in Cent. f Bakt. I Abt. Ref., 42, 1908-09, 595; Micrococcus minimus Berney et al., Manual, 1st ed , 1923, 69; Prévot, Ann Sei, Nat , Sér Bot , 15, 1933, 125.) From Latin, minimus, teollema

Differs from Veillonella parvula only in its slightly smaller size (0 2 to 0 3 mieron), Growth only at 37°C No growth ongelatin. Growth on the wall of the culture tube in fine flakes, not clouding the medium, and no plasmolysis in a 5 per cent salt solution.

Source: Isolated from a perinterine abscess.

1b. Veillonella parvula var branhamii Prévot. (Anaerobie micrococcus, Branham, Jour Inf. Dis , 41, 1927, 203; abid , 42, 1928, 230. Micrococcus brankamii Bergey et al., Manual, 3rd ed , 1930, 92, Prévot, Ann. Sei. Nat , Sér Bot , 15, 1933, 126 ) Named for Dr. Sara E Branham, of the National Institute of Health, Washington, D. C.

Serologically distinct from Veillbnella parvula. One strain liquefied gelatin slowly.

Source: Isolated from nasal washings in two cases of influenza

1c. Veillonella parvula var. thomsonii Prévot. (Anaerobie diplococcus, Thomson, Jour. Trop. Med and Hyg., 26, 1923, 997 and Ann Pickett-Thomson Res Lab., 1, 1924-25, 105 and 164, Prévot. Ann. Sci. Nat . Sér Bot . 15, 1933, 126; Micrococcus thomsoni Handurov et al Diet d. Bact Path . 1937 283 ) Named for Dr. David Thomson of London. England

Differs but slightly from Veillanella pareula in that it requires some accessory factor of growth found in serum or similar body fluids, testicular agar and the like.

Source · Found in the throat in measles and conslat faster

2 Veillonella gazogenes (Hall and

Howitt) Murray (Macrococcus caro. genes alcalescens angerobius Lewkowicz. Arch Méd Exp., 15, 1901, 633, Micrococeus ogrogenes Hall and Howitt. Jour Inf. Dis , 37, 1925, 112, not Micrococcus gazogenes Choukévitch, Ann Inst Pasteur, 25, 1911, 356, Veillonella alcalescens Prévot. Ann. Sci. Nat. Sér. Bot . 15. 1933, 127: Micrococcus alcalescens Haudurov et al . Dict d Bact Path . 1937, 274; Murray, in Manual, 5th ed. 1939, 287) From Latin, the gasproducing Veillonella

The species name gazogenes as given by Hall and Howitt is well established in the btersture for this arganism. It is valid under the rules when the organism is placed in a new genus (Veillonella) in spite of the earlier use of Micrococcus gazogenes by Choukévitch for a different organism

Spheres 03 to 07 micron, average 04 mieron, occurring in irregular masses. rarely in pairs, short chains or singly. Gram-negative.

Gelatin No liquefaction.

Deepagar colonies At first punctiform, becoming lenticular. Gas bubbles appear after 16 to 18 hours.

Blood agar plate. Minute colonics. Non hemolytic. Several strains show greenish colonies.

Peptone broth: Gas produced Broth becomes slightly alkaline.

Indole not formed.

Milk: Gas, but no acid. No coagulation.

Ammonia and hydrogen produced in small amounts.

Egg-white and coagulated serum not attacked.

Hydrogen sulfide not produced.

Carbohydrates not attacked.

Nitrites not produced from nitrates.

Slowly plasmolysed in 5 per cent NaCl

solution.
Optimum pH 6.0 to 80 Will grow in

broth of pH 5 5.

Temperature relations: Optimum 37°C.
Some strains grow at 22°C. Killed at 56°C in one hour, or at 65°C in a half

nour, or at 80°C in 10 minutes.

Non-pathogenic (Lewkowicz's strains).

Two strains (Prévot) pathogenic for rabbits.

Strict anaerobe.

Distinctive characters: Differs from Veillonella parvula in that it does not ferment sugars, does not produce H<sub>1</sub>S nor indole, is not hemolytic, does not produce nitrites from nitrates, and does not develop fettid dofers.

Source: Isolated (Lewkowicz) from mouth of a healthy infant. Twenty-four strains (Hall and Howitt) from human salva Fitteen strains (Prévot) one from alveolar pyorthea, one from pulmonary gangrene, 5 from tonsils, one from appendix, 2 from measles, 3 from scarlet fever, and 2 from normal guinea pigs and rabbits.

Habitat: Prevalent in saliva of man and animals.

2a. Veillonella gazogenes var ginginalis Murray. (Kluiner Micrococcus, Ozaki, Cent. f. Bakt, I Abt., Orig., 62, 1912, 83; Micrococcus gingualis Bergey et al., Manual, 1st ed., 1923, 69; Veillonella alcalescens var. gingualis Prévot, Ann. Sci. Nat., 58r. Bot., 15, 1933, 133; Murray in Manual, 5th ed., 1939, 288.) From Latin, pertaining to the gums. Differs from Veillonella gazogenes by its ability to grow at 22°C, and by the fact that glucose favors its growth although this carbohydrate is not fermented.

Source: Oral cavity and (Prévot) two strains from the intestine.

2b. Veillonella gazagenes var. munutssima Murray. (Micrococcus minutssimus Oliver and Wherry, Jour. Inf. Dis. 22, 1921, 312; Feillonella alcalescens var munutissima Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 134; Murray, in Manual, 5th cd., 1939, 253.) From Lattin, very tiny.

Differs from Veillonella gazogenes only in that the usual carbohydrates favor growth and that the gas formed is not absorbed by sodium hydroxide and

is not inflammable.

Non-pathogenic for rabbits, guinea pigs or white mice (Oliver and Wherry).

Source: Two strains isolated from a mixed infection in aphthous ulcers of the gingival and buccal mucosa of a case of postpoliomyelitic paralysis.

2c. Veillonella gazogenes var. syrygot Murray. (Syrygiococcus scarlatinae Heitberg, Cent. f. Bakt., I. Abt., Ref., 89, 1928, 575; Micrococcus syrygios scarlatinae Herzberg, Cent. f. Bakt., I. Abt., Orig., III, 1929, 373; Micrococcus syrygios Bergey et al., Manual, 3rd ed., 1930, 92; Veillonella acalascens var. syrygios Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 134; Murray, in Manual, 5th ed., 1939, 283.) From Latin, yoked.

Differs from Veillonella gazogenes only by its ability to grow under an atmopheric pressure of 4 cm mercury, with the formation of H<sub>2</sub>S in small amounts by some strains, and the production of nitrites from nitrates.

Source: Found by Herzberg in 30 per cent of normal mouths and in 100 per cent of saliva from scarlet fever patients.

#### FAMILY VII LACTORACTERIACEAE ORLA-JENSEN

(Orla-Jensen, Jour. Bact, 8, 1921, 271; Streptobacteriaceae Bergey, Breed and Murray, Preprint, Manual, 5th ed., 1938, 71)

Long or short rods, or cocci which divide like rods in one plane only, producing chains, but never tetrads or packets. Non-motile except for certain cultures of streptococci. Gram-positive Pigment production is rare; a few species form a yellow, orange, red or rusty brown pigment. Surface growth on all media is poor or absent. Some species are strictly annerobic. Carbohydrates are essential for good development; they are fermented to lactic acid, sometimes with volatile acids, alcohol and CO<sub>2</sub> as by-products (except for the non-fermenting Diplococcus magnits). Gelatic is very rarely liquefied. Nitrate is not reduced to nitrite. Found regularly in the mouth and intestinal tract of man and other animals, dairy products, fermenting verstable juices. A few are highly pathogenic.

### Key to the tribes of family Lactobacteriaceae.

- I. Cocci occurring singly, in pairs and in chains
- Tribe I. Streptococceae, p 305.
- Rods occurring singly, in pairs and in chains Individual cells may be very long or even filamentous.

Tribe II Lactobacilleac, p. 349

### TRIBE I STREPTOCOCCEAE TREVISAN.

(I genera e le specie delle Batteriacee, 1889, 29 )

Cells spherical or elongate, dividing in one plane only, usually occurring in pairs or chains. A few species are strict ancerobes, none grow abundantly on solid media. Carbohydrates and polyalcohols are changed either by homofermentation to lactic acid or by heterofermentation to lactic and acetic acids, alcohol and carbon diovide. Some pathogenic species grow poorly without blood serum or other enrichment fluids. Cataliase necettive

# Key to the genera of tribe Streptococceae.

- I. Parasites, growing poorly on artificial media Cells usually in pairs, often clongated Anaerobic species rarely in tetrads or small clumps Genus I. Dinlegarcus. p. 305
- II. Parasites and saprophytes Normally forming short or long chains. Ferment glucose to lactic acid with practically no other acids or CO, Genus II. Streptococcus. p. 312

III. Saprophytes Form chains of corect to short rods in plant juices and milk. Perment glucose with the production of CO<sub>3</sub>, better acid, acetic acid and ethyl alcohol. Mannitol is formed from fructose.

Genus III. Leuconostoc, p 316.

# Genus I. Diplococcus Weichselbaum

(Weichselbaum, Wiener med Jahrh , 82, 1886, 483, Hydlococcus Schroeter, in Cohn, Kryptogamen Flora v. Schlesien, 1886, 152, Pseudoliplococcus Bonome, Cent. f. Bakt.,

<sup>\*</sup> Revised by Prof. E. G. D. Murry, McGill University, Montreal, Canada, September, 1938; anaerobic section adapted from papers by Dr. A. R. Prévot, Institut Pasteur, Paris, France, 1935, further revision by Lt. Col. Filiatt S. Robinson, M.C., Washington, D. C., January, 1944

1888, 321; ? Pneumococcus Schmidlechner, Ztschr. f. Geburtshilfe u. Gynākol., 66,
 1905, 201; not Pneumococcus Arloing, Compt. rend. Acad. Sci., Paris, 109, 1889, 430;
 Mogallia Enderlein, Sitzb. Gesell. Naturf. Freunde, Berlin, 1917, 300.) From Greek diploos, double; lokkos, a grain or berry; M. L., a sphere.

Cells usually in pairs, sometimes in chains or more rarely in tetrads or small clumps. Young cells Gram-positive. Parasites sometimes growing poorly or not at all on artificial media. Fermentative powers usually high, most strains forming acid from glucose, lactose, sucrose and inulin. The aerobic species are bile soluble while the anaerobic species are not bile soluble.

The relationships of the strictly anaerobic diplococci placed in this genus by Prévot (Ann. Sci. Nat., Sér. Bot, 15, 1933, 140) to pneumococci are not yet entirely clear. The anaerobic species are included here in the hope that this arrangement will stimulate research.

The type species is Diplococcus pneumoniae Weichselbaum.

### Key to the species of genus Diplococcus.

- I. Aerobic, facultative. Bile soluble.
  - Diplococcus pneumoniae.
- II Strictly anaerobic. Not bile soluble.
  - A Greater than 1 micron in diameter.
    - 1 Carbohydrates not attacked.
    - Diplococcus magnus.
  - B. Not greater than 1 micron in diameter.
    - Acid from glucose and lactose.
    - a. Capsulated. Pathogenic.
      - 3. Diplococcus paleopneumoniae.
      - aa. Not capsulated. Non-pathogenic.
    - Diplococcus plagarum-belli.
       Acid from glucose, not from lactose.
      - a Grows on ordinary culture media. Non-pathogenic-5. Diplococcus constellatus.
      - aa. No growth on ordinary culture media. Pathogenic.
        - 6. Diplococcus morbillorum.
- 1. Diplococcus pneumoniae Weichselbaum. (Microbe septicémique du salive. Pasteur, Chamberland and Roux, Compt. rend. Acad. Sci , Paris, 92, 1881, 159; Micrococcus of rabbit septicemia, Sternberg, National Board of Health Bull., Washington, 2, 1881, 781; Coccus lancéolé, Talamon, Communication à la Société anatom de Paris, 68, 1883, 475; Micrococcus pyogenes tenuis Rosenbach, Mikroorganismen bei den Wundinfektionskrankheiten des Menschen, 1884, 30 (see Neumann, Cent. f. Bakt., 7, 1890, 177); Micrococcus pasteuri Sternberg, Trans. Pathol. Soc. of Philadelphia, 12, 1885, 162 (not Micrococcus pasteuri

Trevisan, I generi e le specie delle Batteriacee, 1889, 34); Weichselbaum, Wiener med. Jahrb., 82, 1886, 485; Pneu-Pneumococcus, moniemikrococcus or Frankel, Ztschr. f. klin. Medizin, 10, 1886, 402; Bacillus septicus sputigenus Flugge, Die Mikroorganismen, 2 Auf, 1886, 262; Bacillus salivarius septuus Biondi, Ztschr. f. Hyg , 2, 1887, 195; Diplococcus lanceolatus sive capsulatus Fol and Bordoni-Uffreduzzi, Archivio per le Sci Med., 11, 1887, 387; Streptococcus lanceolatus pasteuri Gamaloia, Ann. Inst. Past., 2, 1888, 442; Streptococcus lanceolatus Gamaléia, ibid., 413; Klebsiella salivaris Trevisan, I generi e le specie

rosenbachii Trevisan, ibid., 33: Micrococcus nuocenes-tenuis De Toni and Travisan in Saccardo Sullogo Fungarum 8. 1889. 1031 · Micrococcus pneumonage croungage Sternberg, Cent. f Bakt. 12. 1892. 53: Diplococcus Innceolatus cansulatus Kruse and Pansini, Ztschr. f Hyg. 11 1802 235. Dinlococcue lanceolatus incorrectly ageribed to Frankel by Binaghi, Cent. f. Bakt. J Abt. 92, 1837. 278: Micrococcus tenus Migula Syst. d. Bakt., 2, 1900, 193; Bacterium nneumontae Migula, ibid., 317. Bacterium salitarium Migula, abid . 379: Strentonneumoniae Chester. Determ. Bact., 1901, 63: Micrococcus lanceolatus Longcope, Jour Med Res . 7 (N.S. 2), 1902, 220: Pneumococcus lanceolatus Schmidlechner. Ztschr Geburtshilfe u. Gynäkologie, 56, 1905. 201; Pneumococcus pneumoniae Fried, Jour, Exp. Med . 57, 1933, 111 ) From Greek meumonia, inflammation of the lunes

delle Batteriacee, 1889, 26: Micrococcus

Monas pulmonale Klebs (Arch f exper. Path. u. Pharmakol, 4, 1875, 472) is inadequately described by Klebs and ought not to be regarded as identical with Weichselbaum's oreanism.

Common name: Pneumococcus

The organisms occur as oval or spherical forms typically in pairs, occasionally singly or in short chains, 05 to 125 microns. The distal ends of each pair of organisms tend to be pointed or lancet-shaped. Encapsulated. Non-motile Young cells, Gram-positive.

Gelatin stab; Filiform or beaded growth. No liquefaction.

Infusion agar colonies: Small, transparent, grayish, with entire margin-Elevation high convex, glistening, mucoid to watery.

On blood agar, the colonies are elevated at the center with concentric elevations and depressions. Hemolysis usually slight but often marked in anerobic culture; methemaglobin formation with

Beef heart infusion broth Uniform turbidity with variable amount of sediment.

Addition of glucose, scrum, whole blood or ascitic fluid enhances growth.

Meat extract media: Growth irregular, usually poor if any.

Inulin serum water. Usually acid with congulation

Litmus milk: Usually acid with coagulation.

Potato · No growth.

Whole bile or 10 per cent solutions of sodium taurocholate or sodium glyco-cholate added to actively growing broth cultures will dissolve the organisms It is customary to use from 0.1 to 0.5 ml of bile for each 0.5 ml of culture

Aerobic, facultative.

Optimum temperature 37°C. Usually no growth at 18° to 22°C

Optimum initial pli 78

Source Sputum, blood and evudates in pneumona; cerebrospinal fluid in meningitis; mastoiditis; cittis media, peritonitis, empyemi; percarditis, endocarditis, arthritis, saliva and secretions of respiratory tract in normal persons. Commonest cause of lobus pneumona.

Habitst. The respiratory tract of man

At present, thirty-one types of Diplococcus pneumoniae are recognized on the basis of serological reactions, chiefly the Neufeld "Ouellung" phenomenon as induced by type-specific immune rabbit serums. Following the description of Pneumococcus 1 by Neufeld and Händel (Arb. a. d k Gesundheitsamte, 31, 1910. 293). Dochez and Gillespie (Jour Amer Med. Assoc , 61, 1913, 727) divided the species into Types 1, 2, 3 and a heterogenous group 4: Cooper, Edwards and Rosenstein (Jour. Exp. Med , 49, 1929, 461) separated Types 4 to 13 from the strains previously designated as group 4. and later Cooper, Rosenstein, Walter and Peizer (Jour. Exp Med., 55, 1932, 531)

continued the classification to Type 32. Due to marked cross-reactions, it was subsequently decided that Type 6 was identical with Type 26, and that Types 15 and 30 were identical. This resulted in the deletion of the Cooper Types 26 and 30, thus leaving thirty of the original thirty-two types. Type 33 (Wilder) has been described by Walter, Blount, Beattie and Cotler (Jour. Inf. Dis., 66, 1940. 181) as a distinct type; sufficient recognition has been accorded to justify the acceptance of this type, thereby making a total of thirty-one types of the species. In a still more recent publication, Walter, Guevin, Beattie, Cotler and Bucca (Jour. Immunol., 41, 1941, 279) recommend the addition of nine new types and eight subtypes. These, together with new strains reported by Kauffmann, March and Schmith (Jour. Immunol., 39, 1940, 397), if eventually recognized, would make a total of fifty-five types. Eddy still more recently, taking into account all known types, raises the number of recognized types to seventy five (U. S. Public Health Repts., 59, 1944, 449-468).

Note 1. Streptococcus mucosus Howard and Perkins (Howard and Perkins, Jour. Med. Res., 6 (N.S 1), 1901, 174; Diplococcus capsulatus incorrectly attributed to Frankel by Binaghi, Cent f. Bakt , I Abt., 22, 1897, 273; Streptococcus mucosus Schottmuller, Munch. med. Wehnschr., 50, 1903, 909, Streptococcus lanceolatus var. mucosus Park and Williams, Diplococcus lanceolatus var. mucosus Park and Williams, Diplococcus mucosus Park and Williams, Pneumococcus mucosus Park and Williams. Jour. Exp Med , 7, 1905, 411; Streptococcus mucosus capsulatus Buerger, Cent. f. Bakt , I Abt , 41, 1906, 314 ) This organism is no longer recognized as a separate species Dochez and Gillespie (Jour. Amer. Med Assoc, 61, 1913, 727),

Wirth (Cent f. Bakt., I Abt, Orig, 102, 1928, 40) and others have established the identity of strains of this group as Diplococcus pneumoniae, Type 3.

Buerger (Cent. f. Bakt., I Abt., Orig. 41. 1906. 314) lists the following capsulated closely related streptococci: Streptococcus involutus Kurth, Arb. a. d. k. Gesundheitsamte, 8, 1893, 449 (Diplococcus involutus Winslow and Winslow, The Systematic Relationships of the Coccaceae, New York, 1908, 131); Streptococcus aggregatus Scitz, Cent. f. Bakt., I Abt., 20, 1896, 854; Streptococcus capsulatus Binaghi, Cent. f. Bakt., I Abt, 22, 1897, 273; Streptocoque auréole, Le Roy des Barres and Weinberg, Arch de Méd. expér. et d'anat. pathol., 2, 1899, 399; Leuconostoc hominis Hlava, Cent. I Bakt., I Abt., Orig., 32, 1902, 263

Note 2. Pneumococci, regardless of scrological type, manifest three chief culture phases (or stages): Mucoid, Smooth, and Rough. The Mucoid (M) form corresponds to that previously designated as Smooth (S) and represents the typical phase of the species; Smooth (S) supercedes the earlier term Rough (R); and the present Rough (R) form is a relatively newly-described variant. The most frequently observed dissociative trend is M → S → R. Serological types are recognizable only in the Mucoid form due to the presence of type-specific polysaccharides in the capsular material, both Smooth and Rough forms are devoid of capsular material, but possess species specific antigens common to all members of the species. Smooth and Rough forms are non-pathogenic, possess distinctive growth characteristics, and require special technic for accurate observations The cultural characteristics given are those of the mucoid and smooth phases only, e. g , see growth in broth.

\*† Diplococcus magnus Prévot. (Diplococcus magnus anaerobius Tissier and

Anaerobic section reviewed by Dr. Ivan C. Hall, New York, N. Y.

<sup>†</sup> These anaerobic diplococci and streptococci, many of which are putrefactive

Martelly, Ann. Inst. Past., 16, 1902, 885; Prévot. Ann. Sci. Nat.. Sér. Bot . 15. 1933. 140.) From Latin magnus, large.

Large apheres: 1.5 to 18 microns. usually in pairs, sometimes occurring Bingly, in small clumns or very short chains, Gram-positive

Gelatin Growth slow, scanty, No. liquefaction

Deen agar colonies: After 24 hours at 37°C, lenticular, whitish, granular, margin finely cut. No gas produced. Broth: Turbid, clearing in 4 or 5 days

resulting in a viscous mass similar to the zoogloca which Clostridium bifermentans forme

Pentone water Slight turbidity Indole not formed

Milk · Unchanged.

Fibrin not directed.

Sterilized uring. Turbid in 3 to 4 days The urea is attacked forming (NIL), CO.

Proteoses: Directed and disintegrated forming (NIL),CO, with the liberation of NH.

Carbohydrates not attacked

Optimum pH 7.0 Limits of pH 5.5 to 8 5

Temperature relations Optimum 37°C Grows from 18° to 37°C. Killed in five minutes on boiling or in half an hour at 60°C.

Non-pathogenic Strict anaerobe

Distinctive characters: Large size, very marked alkalinizing power

Source Isolated by Tissier Martelly (loc. cit ) from putrefying butcher's ment Isolated by Prevot (loc. cit.) from a case of acute anpendicitis.

Habitat - Human directive Very common on hutcher's meet in the process of putrefaction Probably occurs in household dust

3. Diplococcus naleoppeumoniae Prévot. (An anaerobic pseudopneumococcus. Rist. Thèse de Paris. 1898. Der Frankelsche Diplococcus, Bolognesi, Cent f. Bakt. I Abt. Orig. 43, 1907, 113; Prévot. Ann. Sci. Nat., Sér. Bot., 15. 1933. 143 ) From Greek paleus, old and nneumania inflammation of the lungs

Spheres About 0.7 to 1.0 micron, occurring in pairs, rarely occurring singly or in very short chains. Cansulated. Gram-positive

Gelatin : No liquefaction

Deep agar colonies: Probably Jenticular

Agar slant colonies: Round, raised, transparent, dew-drop.

Broth Opalescent turbidity which settles as a rather abundant, powdery. floceulent precipitate No cas produced. Glucoso or lactose broth Rapid. abundant crowth.

Pentone water (2 per cent); Very slow development After 4 or 5 days at 37°C growth very poor

Milk, Good growth, Partial congu-

Blood agar, Very rapid, abundant emwth.

Acid from glucose and lactose. Temperature relations Ontimum 37°C.

No eronth at 20°C nor at 42°C. Killed at 55°C.

Pathogenic Strict anaembe.

Distinctive characters.

and gas-forming, seem to us so different from the fermentative microscrophilic diplococci, streptococci, leuconostucs and lactobacult that we belence they should be placed in genera and in a family separate from Lact bacteriaceae Prévot in a discussion (Ann Inst Past , 67, 1911, 87) that has just reached us (Oct , 1915) recognizes this difference in physiology. He would solve the difficulty by returning the fermentative diplococci and streptococci to the family Coccaceas because of resemblances in morphology which do not seem to us to be fundamental-The chitors.

Diplococcus pneumoniae but is a strict anaerobe; highly pathogenic.

Source: Isolated by Rist (loc. cit.) from an osseous abscess; by Bolognesi (loc. cit.) from lesions of pleuropneumonia.

Habitat: Buccal-pharyngeal cavity of man and rodents.

 Diplococcus plagarum-belli Prévot. (Diplococcus from septie wounds, Adamson, Jour. Path. and Baet., 22, 1919, 393; Prévot, Ann. Sci. Nat., Sér. Bot., 15, 1933, 157.)
 From Latin plaga, wound; bellum, war.

Spheres 0.6 to 1.0 micron, occurring in pairs of unequal size or in short chains. Gram-positive.

Gelatin: No liquefaction.

Deep agar colonies: Appear after 24 to 48 hours, gradually increasing in size to 2 mm in diameter; lenticular, regular, almost transparent. Gas not produced, even in glucose agar.

Broth: Growth precipitates in 5 or 6 days No cas produced.

Indole not formed

Milk: Strongly acidified and coagulated in 2 to 3 days.

Serum not digested.

Acid but not gas from glucose, maltose, lactose and sucrose. No acid from mannitol

Temperature relations. Optimum 37°C. Not always killed in half an hour at 80°C.

Non-pathogenic.

Strict anaerobe.

Source: Sixteen strains isolated from fifty-one cases of septic war wounds.

Habitat · Common in septic wounds.

 Diplococcus constellatus Prévot. (Compt. rend. Soc. Biol. Paris, 91, 1924, 426.) From Latin constellatus, studded with stars.

Description in part from Prévot, Ann Sci. Nat., Sér. Bot., 15, 1933, 158.

Spheres: 0 5 to 0.6 micron, occurring in pairs and tetrads, rarely in very short chains, never in clusters. Grampositive.

Gelatin: Good growth. No liquefaction.

Deep agar colonies: At first very small, lenticular, biconvex, thick, opaque, yellowish, 0.5 to 1.5 mm in diameter. Each colony surrounded by many small satellite colonies visible microscopically

Broth: Growth slow, poor. After 48 hours a slight homogenous turbuilty which quickly clears, leaving a slight powdery sediment. Neither gas nor odor produced.

Glucose broth: Growth rapid, abundant.

Proteins not attacked.

Blood broth: Good growth. No hemolysis.

Milk: Poor growth. No change.

Peptone water: Good growth. Not acidified. Indole not formed.

Neutral red broth unchanged.

Acid but not gas from glucose, arabinose. Slightly acid from glycerol. No acid from lactose, inulin, mannitol or dulcitol.

Optimum pH 6 0 to 8 0.

Optimum temperature 37°C. Feeble growth at 22°C. Not thermo-resistant

Strict anaerobe.

Distinctive character: The microscopic appearance of agar colonies each of which is surrounded by a constellation of satellites.

Source: Isolated from a case of chronic, cryptic tonsillitis. Later isolated from pus in acute appendicitis

Habitat: Digestive tract, especially the lymphoid tissues, as tonsils and appendix.

6. Diplococcus morbillorum Prévol.
(Diplococci from cases of measlet,
Tunnicliff, Jour. Amer. Med. Assoc., 63,
1917, 1028; Diplococcus rubolota Tunnicliff, Jour. Inf. Dis., 52, 1933, 39; Prévol.
Ann. Sci. Nat., 5¢r. Bot., 15, 1933, 18;
original name withdrawa by Tunicliff,

Jour. Inf Dis., 58, 1936, 1.) From Latin morbus, disease; M. L. morbills, measles

Spheres 06 to 08 micron, occurring in short chains, rarely in small masses Gram-positive.

This organism does not develop on ordinary culture media. The addition of fresh scrum or ascitic fluid is necessary

Gelatin: No liquefaction.

Serum agar colonies: Very small, punctiform, appearing after 5 to 22 days No gas produced.

Glucose agar containing ascitte fluid and blood: Colonies are slightly larger and appear more rapidly, greenish.

Blood agar colonies: Surrounded by a greenish halo. May be large and moist. Gas not produced

Broth: Very poor growth.

Hemolysed blood broth: Growth flocculent, leaving the liquid clear. Milk: Unchanged by most strains. Acidified and coagulated by four strains. Indole not formed

Bile: Not soluble in bile.

Acid from glucose, sucrose and

Temperature relations: Optimum 37°C. Killed in 45 minutes at 57°C. Withstands -2°C for two weeks.

Strict anaerobe. Most strains become microaerophilic with transfers.

Distinctive characters. Greenish colonies on blood media; poor growth on ordinary media.

Source: Isolated from the throat and blood in measles.

Habitat. Nose, throat, eyes, ears, mucous secretions and blood from cases of measles

### Genus II. Streptococcus Rosenbach.\*

(Rosenbach, Mikroorganismen bei Wundinfektionskrankheiten des Menschen, 1881, 22; Arthrostreptolokkus Hueppe, Wiesbaden, 1886, 141; Sphaerococus Marpman, Erganzungshelte z. Cent. f. allg. Gesundheitspflege, 2, 1889, 121; Perroncutoa, Babesia, Schuetzia Trevisan, I generi e le specie delle Batteriacee, 1889, 29; Lactococcus Beijerinck, Arch. ne6rl. d. sci. evactes, 86r. 2, 7, 1901, 213; Hypnococcus Bettencourt et al., Cent. f. Bakt., I Abt., Orig., 45; 1901, 55; Myococcus Gonnermann, Dester. u Ungar. Ztschr. f. Zuckerind. u. Landwirtsch., 36, 1907, 883; not Myzococcus Thavter, Bot. Gaz., 17, 1892, 401; Melcocccus Amiradribi, Med. Zurn., 4, 1907, 309; Diplostreptococcus V. Lingelsheim, in Kolle and Wassermann, Handb. d. path. Mikroorg, 2 Aufl., 4, 1912, 494; ? Brachybacterium Troili-Petersson, Cent. f. Bakt., II Abt., 11, 1903, 138; Pseudostreptus Enderlein, Sitzb. Gesell. Naturf. Freunde, Berlin, 1917, 309, Planostreptococcus Meyer, Die Zelle der Bakterien, Jena, 1912, 4; Streptus Enderlein, Sitzb. Gesell. Naturf. Freunde, Berlin, 1930, 101; Peptostreptococcus Kluyver and Van Niel, Cent. f. Bakt., II Aht., 94, 1930, 391.) From Greek streptus, flevable or pliant; Greek kokkos, a grain or berry; M. L., a sphere.

Cells spherical or ovoid, rarely elongated into rods, occurring in pairs, or short or long chains, never in packets or zooglocal masses. Capsules are not regularly formed, but become conspicuous with some species under certain conditions. Gram-positive, some species decolorizing readily. A few cultures produce a rusty red growth in deep agar stab, or a yellow or orange pigment in starch broth. Growth on artificial media is slight. Agar colonies are small. Surface colonies are translucent. Colonies may be effuse, convex or mucoid. Some species are aided by the addition of native proteins Mostly facultative anaerobes, with little surface growth in stab cultures. A few are strict anaerobes. Some of the latter attack proteins with production of gas and foul odors. Carbohydrate fermentation by all others is homofermentative, with dextrorotatory lactic acidas the dominant product, while volatile acids, other volatile products and CO2 are either absent or produced in very small amounts. Inulin is rarely attacked. Nitrate is not reduced to nitrite. Not soluble in bile. Common wherever organic matter containing sugars is accumulated. Regularly in the mouth and intestine of man and other animals, dairy products, fermenting plant juices. Some species are highly pathogenic

The type species is Streptococcus pyogenes Rosenbach.

Note: The classification of streptococci is beset with many difficulties and it seem advisable for the present to accept only such described species about which there are assamble agreement. With present knowledge, many species which have been esparated can justifiably be considered as identical with older species and have been exact identification now and they have been classed as invalid names with no present exact identification now and they have been classed as invalid names with no present significance. It is admitted there are grounds for belief that more than one species may be included in certain of the species described here, but the onus of proof lies with the investigators interested in them. It is hoped that the simplification introduced will prove useful as a starting point for the more exact differentiation and description of the species of Streptococcus. The general arrangement used is in

<sup>\*</sup> Revised by Prof E G D Murray, McGill University, Montreal, Canada, in consultation with Prof G J Hucker, New York State Experiment Station, Geneva, New York and Prof. J. M. Sherman, Cornell University, Ithaca, New York, June, 1938; further revision by Prof. J M Sherman, February, 1944.

harmony with the suggestions made by Hucker (Proc. 2nd Internat, Cong. for Microbiology, London, 1936, 127) and Sherman (Buct. Reviews, J., 1937, 3). Serological reactions are included as fir as possible in the descriptions but the true

significance of these methods is not known and on that account they are not stressed in the primary classification.

Throughout the history of this genus motile streptococci have been reported occasionally (e.g., Streptococcus kerbarium Schieblich, Cent. f. Bakt., I.Abt., Orig., 124, 1932, 291; Koblinüller, Cent. f. Bakt., I.Abt., Orig., 135, 1934, 310, Stülting, Cher die Streptokokken des normal redenden Tilister Kises. Insig. Dies., Kiel, 1933, 51; Poa nall, Brit., Jour. Exp. Path., 16, 1933, 153) but it is not known whether these constitute definite species or whether (Levenson, Ann. Inst. Past., 69, 1938, 99) motile individuals occasionally appear in ordinarily non-motile species.

The anaerobic streptococci have not been sufficiently studied to be sure whether they should be included in the genus Streptococcus or given separate generic rank. Their metabolic processes seem reason for the latter view. The descriptions given are taken from Privot (Ann. Sci. Nat., Sci. Bot., 15, 1933, 23)

The material is arranged accordingly in three categories: A key and complete descriptions have been prepared for clearly defined species, species of uncertain taxnomic relationships have been placed in Appendix I with their necessarily incomplete descriptions, while even less valid and unidentifiable species are merely listed in Appendix II.

### Key to the species of genus Streptococcus.

I. Pacultative anaembic species

A. Programe group—No growth at 10°C. No growth at 45°C. Generally testa hemolytic. Generally do not curille litinus valls, and reduce littinus valuely if at all. Mannitol and glycerol generally not terrented. Not tolerant of 0.1 per cent methylere blue, 6.5 per cent NaCl and pH 26. Profuce aumonotat from reprocess.

I. Solum hippurate not hydrolyzed

a. Lectore fermented

b Solutal not fermented but trebalous fermented. Innerfield. Group V.

1 Strept words property

bb. Subutol fermented and trelabuse not fermented. Innecfeld

Group C.

2. Strept viscous a superferences

as Lacture may or may not be ferriented. Lacrefeld Group C.
b. Trelalone not fermented.

2. Street recovers:

bb Tret store fermented

4. Strpfwicent equipment

2 Set in high me hydriand. Invested Group B

B. Verlangeon. Nogenthal 10°C. Genetical 40°C flow energy neight Supplied and at Bellind for antiferent logalities makes of a subground promition formetted, a single state of the logality Of the next particles for Copie and Verlang 11.9°C. No beau hemolytic (though they may be under anaerobic conditions) but show varying degrees of greening of blood. Do not produce ammonia from pertone (few exceptions in Strentecoccus mitis).

1. Lactose is fermented.

- a. Do not grow at 50°C. Greening or indifferent in blood agar. Raffinose, inulin, salicin and devtrin generally fermented. Esculin generally attacked. Growth with 2 per cent NaCl.
  - b. Do not survive 60°C for 30 minutes. Starch not hydrolyzed. Not tolerant of bile.
    - c. Mucoid colonies produced on sucrose and raffinose medu
      6. Strentococcus saligarius.
    - cc. Colonies not mucoid on sucrose or raffinose media. Inulia not fermented.
      - 7. Streptococcus mitis.
  - bb. Survives 60°C for 30 minutes. Starch is hydrolyzed except by variety inulinaceus. Tolerant of bile.
    - 8. Streptocorcus bovis (and varieties).
- aa. Grows at 50°C. No action on blood. Esculin not attacked. Raffinose, inulin, salicin and dextrin not fermented. No growthin 2 per cent NaCl.
  - 9. Streptococcus thermophilus
- 2. Lactose not fermented. Tolerant of bile.
- 10. Streptococcus equinus.
- C. Lactic group Growth at 10°C. No growth at 45°C. Reduce litmus prior to curdling of litmus milk. Sorbitol and glycerol not fermented. Not beta hemolytic. Tolerate 0.1 per cent methylene blue, but do not tolerate 6.5 per cent NaCl or bH 9.6.
  - Maltose and deatrin fermented. Ammonia produced from peptone Growth at 40°C Group N of Shattock and Mattick.
    - 11. Streptococcus lactis.
  - 2 Maltose and usually dextrin not fermented. Ammonia not produced from peptone No growth at 40°C.

12. Streptococcus cremoris.

- D. Enterococcus group. Growth at 10°C. Growth at 45°C. Usually reduce litmus prior to curdling litmus milk. Sorbitol, glycerol and mannitol generally fermented. May or may not be beta hemolytic. Tolerate 0.1 per cent methylene blue, 6.5 per cent NaCl and pH 9.6. Ammonis produced from pentone. Lancefield Group D.
  - 1. Not beta hemolytic.
    - a. Gelatin not liquefied.
    - Streptococcus faccalis.
       aa. Gelatin liquefied.
    - -
- 14. Streptococcus liquefaciens.
- Beta hemolytic.
  - a Mannitol and sorbitol fermented.
    - Streptococcus zymogenes.
- aa Mannitol and sorbitol not fermented.
  - 16. Streptococcus durans.
- II. Anaerobic species.
  - A. Strict anaerobes.
    - 1. Gas and fetid odor produced.
      - a. No general turbidity in broth.

# PAMILY LACTORACTERIAN OF

h. Arid from maltose.

17. Strentocom. 200 bb. No acid from maltose.

18. Streptococcu: 10

an. Turbidity in broth.

h No gas in Veillon's semisolid +---

19 Streptorocca bh thundint ers in semisolid se ...

20. Streptococce 2. No ras and no fetal odor produced

a. Milk not consulated

21. Streptococc. aa. Milk consulated

h Viscous sediment in broth with age

22. Streptocues. bb. No viscous sediment in beati

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blacken with age. 23. Streptorce. B Microaerophilic

1. Strictly anaerobic on isolation, later c 21 Streptures.

1. Streptococcus pyogenes Rosenbach (Fehleisen, Ueber Ervsipel, Deut Zeit. f. Chir., 16, 1882, 391, Erysspelkokken, Febleisen, Die Actiologie des Lrysipels, Berlin, 1883; Rosenbach, Mil roorganismen bei Wundinfektionskrankheiten des Menschens, 1881, 22. Streptococcus erysipelatos (sic) Rosenbach, thid , 22; Micrococcus erysipelalis Zopf, Die Spaltpilze, 2 Aufl., 1881, 86, Streptococcus erysipelatis Zopf, Die Spaltpilze, 3 Aufl., 1885, 51; Streptococcus erysipelatosus Klebs, Die Allg Path , Jena, 1887, 318; Micrococcus scarlatinae and Streptococcus scarlatinae Klein, Report of the Medical Officer of the Local Government Board for 1885-1889, No 8, 1887, 85, Streptococcus conglomeratus Kurth, Arb. d. k. Gesundheitsamte, 7, 1891, 389; Streptococcus longus von Langelsheim, Zischr. f. Hyg., 10, 1831, 331 and 12, 1831. 308; Streptococcus puerperalis Arloing, Septicimie puerperale, Paris, 1832 (Jordan, Brit Med Jour, 1912, 1); Staphylococcus erystpelatos Hesse, Ztschr. f. Hyg., \$4, 1900, 317; Streptococcus longus pathogenes and erystpelatos Schottmüller, Münch. med. Wehnschr., 50, 1903, 909; . 1. Streptococcus longus herselyticus Sachs, Ztachr. f. Hyg., 63, 1909, 466; Streptococcus

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anally fail; growth is " transparent colonies. athm.grayish-white or " almindant in the con-Growth is increased orse protein. r growth even in infusion

'mmary acrobic cul-

in increased by serum Biet , 52, 1936, 541). No change. Not curdled ' reduced.

G -lucose, maltose, sucrose 012 icid from ambinose, lac-179-

nrose, inulia, glycerol,

colonies to remain discrete. Growth increased by addition of blood or native proteins. Pairs or short chains in surface growth and longer chains in condensation fluid of slants.

Broth: Floculent sediment of tangled, chains, supernatant broth often clear except in very young cultures. No pellicle.

Potato: Very slight or no visible growth.

Litmus milk Acid, seldom curdled, and litmus reduced slowly or not at all. Acid from glucose, maltose, lactose, sucrose, salicin and trebalose. No acid

from inulin, raffinose, arabinose, glycerol, mannitol, sorbitol or dulcitol.

No hydrolysis of sodium hippurate, starch or esculin.

Ammonia is produced from peptone. Temperature relations: Optimum temperature around 37°C. No growth at 10°C or 45°C. Does not survive 60°C

for 30 minutes.

Chemical tolerance. Tolerates 2 per cent NaCl but not 4 per cent and 6 5 per cent Final pH in glucose broth 4 8 to 6.0; no growth at pH 9.6. Methylene blue 0.01 per cent and 0.1 per cent not tolerated and not reduced Inhibited by bile but not soluble

Action on blood: Superficial and deep colonies cause hemolysis in blood agar. usually with a wide zone surrounding the colony, which may have a well-defined margin circumscribed by a zone of concentrated hemoglobin; the margin of the zone is ill-defined with some strains. Conditions defined by Brown (Rockefeller Inst Med. Res, Monograph 9, 1919, 14) known as beta hemolysis. Soluble antigenic hemolysin of more than one kind produced in fluid cultures; influenced by constitution of medium and presence of serum; one is oxygen-sensitive and another is oxygen-stable. Special precautions necessary for its demonstration (F. Smith, Jour. Bact. \$4, 1937, 585, 603).

Toxin: An erythrogenic toxin is pro-

duced; commonly associated with scarlet fever. Relatively thermostable.

Fibrinolysin: Dissolves human fibrin but not fibrin of rabbit or ox blood. Markedly thermostable

Serology: Constitutes Group A of Lancefield (C substance; polysaccharide) (Jour. Exp. Med., 67, 1933, 571). Types within the species are distinguishable (M substance; protein); 23 identified by Griffith (Jour. Hyg., 24, 1934, 542). Antigen common to the group (P substance; nucleo-protein) also present in other Gram-nositive cocci.

Facultative anaerobe. Occasionally in primary culture from lesions, pus, etc. grows only in anaerobic culture.

Source: Human mouth, throat and respiratory tract; inflammatory exudates, blood stream and lesions in human disease of very varied character. Occasionally in nulk and udder of cows. Dust in sick rooms, hospital wards and other contaminated sites.

Habitat: In human infections of many varied types. Occasionally in udder infections of cattle and perhaps other animal sources

 Streptococcus zooepidemicus Fost and Engelbrecht. (Animal pyogenes, Type A of Edwards, Jour. Bact., 27, 1934, 527; Frost and Engelbrecht, A Revision of the Genus Streptococcus, privately published, 1936, 3 pp and The Streptococci, 1940, 25; Streptococcus progenes animalis Seelemann, Deutsche tierarzt Wehnschr, 50, 1942, 8 and 48) From M. L, derived to mean animal endemacus.

Morphology and general cultural characters resemble Streptococcus pyogens.
Mucoid colonies are common. Capsules are constantly demonstrable and prominent. Gram-positive

Gelatin stab: No liquefaction.

Litmus milk: May be curdled, litmus not reduced or slowly after curdling.

Acid from glucose, lactose and sorbitol. Acid may be produced from maltose, sucrose and salicin. No acid from arabinose, trehalose, raffinose, inulin, glycerol or mannitol.

Does not hydrolyze sodium hippurate, but starch and esculin may be split.

Ammonia is produced from peptone. Temperature relations: No growth at 10°C or at 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance Tolerates 2 per cent NaCl but not 4 per cent and 65 per cent. Final pH in glucose broth 45 to 52. No growth at pH 96. Methylene blue 0 01 per cent and 01 per cent

not tolerated and not reduced

Action on blood: Beta hemolysis Serology: Group C of Lancefield (loc. cut.). Cross precipitation with Streptococcus equi

Facultative anaerobe

Source: Blood stream, inflammatory exudates and lesions of diseased animals. Not known from man.

Habitat: Disease process of domestic and laboratory animals. (Horse: endometritis, foetus. Hog. septicemia. Cow: septicemia, metritis, foetus Prowls elliped tendon Guinca pig lymphadenitis. Rabbit: septicemia. Fox: pneumona.)

3. Streptococcus equi Sand and Jensen (Bacıllus adenitis equi Baruchello, Soc Veter, de Venetie, Undine, 1886, Giornale di anatomia fisiologica et patologia degli animali domestici, Pisa, Sept., 1887, Sand and Jensen, Deuts. Ztschr f. Tiermed, 13, 1888, 436, dated December 27, 1887, Veterinary Congress, Copenhagen, 1887; sometimes incorrectly credited to Schutz, Arch, f. wissens u. prakt Tierheilkunde, 14, 1888, 172; Streptococcus cappelletts Chester, Manual Determ Bact., 1901, 57; Streptococcus coryzae contagiosae equorum Schutz, in Eisenberg, Bakt, Disg., 3 Aufl., 1891, 270; Streptococcus schütz, Bongert, in Kolle and Wassermann, Handb. d path. Mikroorg., 2 Aufl , 6, '913, 208.) From Latin equus, horse.

Possible synonyms: Streptococcus perstonitidis equi Hamburger, Cent f. Bakt., I Abt., 19, 1896, 882 (Streptococcus perstonitidis Migula, Syst. d. Bakt., 2, 1900, 21), Streptococcus pyogenes equi Hutyra, in Lehmann and Neumann, Bakt Diag., 7 Aufl., 1927, 221.

Nore: Rivolta (Dei parassit vegetali come introduzione allo studio delle malattie parassitarie e delle alterazione dell' alimento degli animali domestici. Turin, 1873, 161) described chains of cocci in adenitis zerophula equorum, morbus glandulosus.

Holth, reported by C. O. Jensen (Handb. d. Serumtherapie u. Serum dagnostik in d. Veterinar-med. (Klimmer-Wolff-Esner), 2, 1911, 223), and Adsersen (Cent. f. Bak., I Abt., Orig, 76, 1915, 111) studied the fermentation reactions of Sand and Jensen's organism. Review of early literature given by Brocq-Rousseau, Forgeot and Urbain (Le streptocoque gourmeux. Revue de Pathologie Comparte et d'Hygiene Générale, Paris, 1925)

Ovoid or spherical cells · 0 6 to 1 micron in diameter, sometimes in pus the long axis of the cells are transverse to the chain, and sometimes in the axis of the chain resembling atterptobacilli; healtlary forms are not rare; occur in pairs, short or long chains; very long chains common in broth eultures Capsules often marked in blood of infected mouse and when grown in serum. Gram-positive.

Gelatin stab: Growth uncertain. No liquefaction.

Nutrient agar: Primary aerobic cultures from pus occasionally fail; growth is poor, small, convex, transparent colonies. Confluent growth is thin, grayish-white or yellowish and more abundant in the condensation water. Growth is increased particularly by horse protein.

Broth: Poor growth even in infusion broth; growth increased by serum (Evans, Jour. Bact, \$2, 1936, 541).

Litmus milk: No change. Not curdled and litmus not reduced.

Acid from glucose, maltose, sucrose and salicin. No acid from arabinose, lactose, trehalose, raffinose, inulin, glycerol, mannitol or sorbitol. No hydrolysis of sodium hippurate.

Temperature relations: Optimum temperature 37°C. Growth slow at 20°C. No growth at 10°C or 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance: Does not tolerate 65 per cent NaCl; final pH in glucose broth 4.8 to 5.5. Methylene blue is not tolerated 0.01 per cent to 0.1 per cent. Inhibited by bile but not soluble.

Action on blood: On blood-agar, colonies are small and watery, dry out rapidly leaving flat glistening colony. Well-defined wide clear zone of hemolysis (beta hemolysis). Groath in serum broth gives a hemolysin active on horse corpuscles, less so on those of sheep and guinea pig.

Toxin: Subcutaneous injection causes necrosis, other evidence of toxin production is defective.

Fibrinolysin · Usually does not lyse human fibrin; some strains reported to do so.

Serology. A member of Lancefield's Group C (Jour Evp. Med, 87, 1933, 571); cross precipitation with Species No. 2 (animal pyogenes) of Edwards (Jour. Bact, 27, 1934, 527). Cultures have been open antigens for production of agglutinating serum and results have been unsatisfactory. Immunized rabbit serum may protect mice from infection, to which mice are very susceptible.

Pathogenicity high for white mice, low or no virulence for rabbits and guinea

Facultative anaerobe; growth in primary culture often better in depth of medium.

Source. Pus from lesions and mucous membrane of upper respiratory tract of horses. Evidence of occurrence in man is unconvincing.

Habitat: Found only in strangles in horses.

4. Streptococcus equisimilis Frost and Engelbrecht. (Human C, Ogura, Jour. Jap Soc. Vet. Sci., 8, 1029, 174; Edwards, Jour. Bact, 23, 1932, 259; ibid, 25, 1933, 527; Sherman, Bact. Reviews, 1, 1937, 35; Frost and Engelbrecht, A Revision of the Genus Streptococcus, privately pub lished, 1936, 3 pp. and The Streptococci, 1940, 45.) From M. L., derived to mean similar to equi.

This species is apt to be confused with Streptococcus equi Sand and Jensen, but it is not as fastidious in its growthrequirements and shows greater toleranced methylene blue, lyses human fibrin and ferments glyccrol and trehalose. It may or may not ferment lactose.

It is also apt to be confused with Strep tococcus pyogenes Rosenbach except for its greater tolerance of methylene blue, glycerol fermentation and especially Lancefield's serological grouping (four Exp. Med., 57, 1933, 371).

Spheres: Gram-positive.

Gelatin: Not liquefied. .

Litmus milk: Acid, may be curdled, litmus not reduced before curdling.

Acid from glucose, maltose, sucrese, trehalose and glycerol; may or may not form acid from lactose and salicin. No acid from arabinose, raffinose, inulin, mannitol or sorbitol.

No hydrolysis of sodium hippurate but may hydrolyze starch and esculin.

Ammonia is produced from peptone.

Temperature relations: No growth at 10°C and 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance: Does not tolerate 6 5 per cent NaCl. Final pH in glucose broth 5 4 to 4.6; no growth at pH 95. Methylene blue 0.1 per cent not tolerated, but Edwards (Kentucky Agr. Exp. Sution Bull. 356, 1938; confirmed by Daris and Gurdar, Jour. Path. and Bact. 45, 1936, 197) finds resistance to 0 00025 mar methylene blue in infusion-casin digest broth. Rarely grows on 40 pct

cent bile-blood agar.

Action on blood: Beta hemolysis.

Fibrinolysin: Dissolves human fibrin.

Scrology: Lancefield (loc. cit) Group C. Facultative anaerobe.

Source: Human nose and throat, vagins and skin; erysipelas and puerperal fever. Uncommon in domestic animals and usually associated with other streptococci (Edwards, loc. cit).

Habitat: Human upper respiratory

Streplococcus dysgalactiae Diernhofer (Milchw. Forsch., 13, 1932, 368), Group II Minett (Proc. 12th Internat. Vet. Cong.,

(Little, personal communication). Physiologically these organisms are like Human C types (Streptococcus equisimities Frost and Engelbrecht) except that they are not hemolytic.

5 Streptococcus agalactiae Lehmann and Neumann. (Streptococcus de la mammite. Nocard and Mollereau, Ann Inst. Past . 1, 1887, 109; Streptococcus nocarda Trevisan. I genera e le specie delle Batteriacee, 1889, 36 (this name rightly has priority and is valid but has remained unused and it would seem unwise to adopt it in place of a name familiar by usage), Streptococcus mastitis sporadicae Guillebeau and Strentococcus mastitis contagiosae Guillebeau. Landw. Jahrb. d. Schweiz, 4, 1832, 27; abst. in Cent f Bakt., 12, 1832, 101: Streptococcus agalactiae contagiosae Kitt. Bakterienkunde, Wien, 1833, 322: Lehmann and Neumann, Bakt, Diag . 1 Aufl., 2, 1896, 126; Streptococcus mastitidis Migula, Syst. d. Bakt., 2, 1900, 19.) From Greek, want of milk

According to Hucker and Harrison (N Y Agr. Exp. Sta. Tech. Bul. 246, 1937, 9), Streptococcus agalactiae Lehmann and Neumann is identical with Group I of Minett, Stableforth and Edwards (Jour. Comp. Path and Ther. 46, 1933, 131) and Group A of Plastridge, Anderson, Brig-

N Y. Agr. Exp Sta. Tech. Bul. 232, 1935. Spherical or ovoid cells. 04 to 12 microns in diameter, occurring in chains of seldom less than four cells and frequently very long; the longer axis of the cells may be in the axis of the chain or may be transverse to it. Chains may appear to be composed of paired cocci. Capsules (?) Gram-positive.

Gelatin stab: Gray, filiform growth

Nutr ent agar. Small gray colonics.

Broth: Growth is variable in character; most frequently a sticky, flaky deposit which may adhere to the side of the tube but the supernatant fluid is clear; long chains are formed.

Starch broth, May produce yellow to orange sediment

Litmus milk: Acid followed by curdling. Litmus reduced subsequent to curdling and proceeds from the bottom upwards Little or no protectivity.

Indole not formed

Acid from glucose, maltose, galactose, fructose, lactose, sucrose, mannose, dexfruit from and trehalose and at times from salicin. No acid from arabinose, raffir nose, inulin, vylose, mannitol, sorbitol or amygdalin. Slight amount of acid from glycerol.

Sodium hippurate is hydrolyzed. No hydrolysis of starch and esculin. Nitrites not produced from nitrates.

Ammoula is produced from peptone. Temperature relations: Optimum temperature 37°C. Range of growth tolerance between 15°C and 40°C No growth at 10°C or 45°C. Does not sur-

NaCl and does not tolerate 6.5 per cent NaCl Final pH in glucose broth 4.2 to 4.6, no growth at pH 9.6. Methylene blue 0.01 per cent and 0.1 per cent not

cent bile.

Action on blood: Variable; between a and j of the strains produce a narrow clear zone of hemolysis; certain strains described as producing greening. The hemolytic strains produce an oxygenstable, filterable hemolysis.

Toxin: No evidence of an erythrogenic toxin.

Fibrinolysin. Does not dissolve human fibrin.

Serology · Group B of Lancefield (Jour. Exp. Med., 47, 1933, 571). Three antigenic types have been separated which appear to be associated with the carbohydrate and not the protein fraction.

Facultative anaerobe.

Source: Isolated from milk and tissues from udders infected with mastitis. Occasionally reported from human sources (Lancefield, Jour. Exp. Med , 57, 1933, 571 ; Hare, Jour. Path. Bact., 41, 1935, 499). Habitat . Udder of cattle with mastitis.

6. Streptococcus salivarius Andrewes and Horder. (Lancet, 2, 1906, 712; Streptococcus cardio-arthritidis Small, Amer. Jour. Med Sci , 173, 1927, 103.) From Latin salivarius, slimy, clammy; M. L., related to saliva.

Description based on studies by Safford, Sherman and Hodge, Jour. Baet., 53, 1937, 263 and Sherman, Niven and Smiley, Jour. Bact., 45, 1943, 249.

Spherical or ellipsoidal cells, 0.6 to 08 micron in diameter, usually in short chains. Long axis of cell lies in axis of chain. Cells are relatively large in liquid media, especially milk. Gram-positive.

Gelatin stab: Filiform growth. No liquefaction

Plain nutrient agar. Colonies white, small, not more than 0.5 mm in diameter. Notwithstanding rather vigorous growth on artificial culture media, cultures die out readily.

Nutrient agar containing 5 per cent sucrose or raffinose produces a large, clear, soft, mucoid colony about the diameter of those produced by coliform bacteria and yeasts. This is quite distinctive as no other known species of streptococcus (except occasional strains of Streptococcus boris) produce colonies of this type on sucrose or raffinose agar. The polysaccharide produced is a soluble levan, some strains producing in addition a smaller amount of insoluble dextran (the polysaccharide in the Streptococcus bovis colonies is a dextran).

Action on blood agar: Indifferent (gamma hemolysis of Brown, Rockefeller Inst. Med. Res., Monograph 9, 1919, 8). No soluble toxin and no hemolysin has been demonstrated

Broth: Variable. Loose, flocculent deposit with clear supernatant fluid and long chains, or uniform or granular turbidity with small deposit and short chains. No pellicle.

Litmus milk: Acidified and curdled promptly by all lactose-fermenting strains. Completely reduced but only after curdling. No digestion.

Potato: Slight growth, Difficult to detect.

Acid from glucose, maltose, sucrose, raffinose, inulin and salicin. No acid from glycerol, mannitol, sorbitol, arabinose or xylose. Trehalose and lactose usually fermented.

No hydrolysis of sodium hippurate and arginine. Splits esculin. Starch is not hydrolyzed.

Ammonia is not produced from peptone

Chemical tolerance: Tolerates 2 per cent but not 4 per cent NaCl. Final ph in glucose broth between 4.4 and 40 No growth at pH 9.6. Methylene blue 0 01 per cent and 0.1 per cent not tolerated. Not soluble in bile but inhibited by 30 per cent bile in blood agar.

Catalase not produced.

Temperature relations: growth 37° to 43°C. Growth at 45°C. No growth at 47°C. No growth at 10°C. Does not survive 60°C for 30 minutes

Facultative anaerobe.

Serology: No group antigen has been demonstrated. Contains several serological types.

Source. Saliva and sputum in various pulmonary infections, apical abscesses of teeth, carious lesions of teeth, intestinal tract.

Habitat: Human mouth, throat and nasopharynx.

7. Streptococcus mitis Andrewes and Horder. (Lancet, 2, 1906, 712) From Latin mitis, mild

Synonyms: Strentococcus mitigr seu piridans Schottmuller, Munch Wehnschr 50 1003 819 (these names refer to a group of species and they are therefore confused in meaning in medical literature. See Winslow and Winslow. The Systematic Relationships of the Coccaceae. New York, 1908, and Safford, Sherman and Hodge Jour Bact 33, 1937. 263). The name Strentococcus mitis was first proposed by Frankel (Munch med Wchnschr , 52, 1904, 548 and 1868) cause others have used this name with varied meanings (Strentococcus mitis seu viridans von Lingelsheim, in Kolle and Wassermann, Handb d path Mikroorg , 2 Aufl., 4, 1912, 453; Streptgeoccus mitis Holman, Jour. Med. Res., 34, 1916, 377). the more definite emendation of Andrep as and Horder has been used as the basis of the description given here The relationshing of these organisms has been discussed by Brown, Rockefeller Inst Med. Res. Monograph No. 9, 1919, 86

Description based on studies by Safford, Sherman and Hodge (loc. cst.) and Sherman, Niven and Smiley, Jour Bact.

45, 1943, 249.

Spherical or ellipsoidal cells, 0 6 to 0 8 micron in diameter Long axis of cell hes in axis of chain. Cells not especially large in liquid media including milk. No capsules Gram-rositive.

Gelatin stab: Filiform growth, No

Nutrient agar: Growth increased when serum or blood is added Confluent growth, gray and abundant.

Action on blood agar. The colonies are surrounded by a characteristic greening (alpha hemolysis of Brown, Rock-feller Inst. Med. Res., Monograph 9, 1919, 8). This is weak with some strains and is variable under anaerobic conditions. No soluble tovin and no hemolysin has been demonstrated.

Broth: Variable. Loose, flocculent de-

posit with clear supernatant fluid and long chains, or granular turbidity with small deposit and short chains. No policie

Latmus milk. Usually acidified and curdled promptly; latmus is completely reduced but only after curdling, no di-

Potato. Slight growth which is difficult

Acid from glucose, maltose, lactose, sucrose and usually salicin. Variable fermentation of raffinose. No acid from mulin, mannitol, sorbitol, glycerol, arabinose or xylose Trehalose rarely fermented.

nose or xylose Trehalose rarely fermented

No hydrolysis of sodium hippurate and
usually no hydrolysis of arginine Action
on esculin usually negative

Usually ammonia is not produced from nentone.

Chemical tolerance. Tolerates 2 per cent but not 4 per cent NaCl Final pil in glucose broth 58 to 42, ave. 45 No growth at pil 96 Methylene blue 0.01 per cent and 01 per cent not tolerated Not soluble in bile but inhibited by 30 per cent bile in blood are.

Catalase not produced

Temperature relations Optimum growth 37° to 40°C Many strains do not grow at 45°C. No growth at 10°C Does not survive 60°C for 30 minutes.

Facultative anaerobe

Serology: No group antigen has been demonstrated Contains several serological types

Source. Saliva and sputum in various pulmonary infections, pus from upper respiratory tract and sinuses, blood and various organs in sub-acute endocarditis. Habitat Human mouth, throat and

nasopharynx

8 Streptococcus bovis Orla-Jensen emend. Sherman (Orla-Jensen, The Lactic Acid Bacterii, 1919, 137; Sherman, Bacteriological Reviews, 1, 1937, 57.) From Latin bos, cow.

The majority of the strains of Strepto-

coccus inulinaceus may be considered as identical with Streptococcus bovis as described here. The so-called Bargen streptococcus (Bargen, Jour. Amer. Med. Assn., 85, 1924, 332; Arch. Int. Med., 45, 1930, 559) is also considered to be Streptococcus bovis.

Spheres: Occurring in pairs and chains. Capsulated in milk, Gram-positive.

Gelatin stab: No liquefaction.

Litmus milk: Acid, curdled in 3 to 5 days, followed by reduction of the litmus.

Acid from glucose, fructose, mannose, galactose, maltose, lactose, sucrose, raffinose and salicin; sometimes from mannitol, sorbitol, inulin, arabinose and trehalose. Not from glycerol.

Starch is hydrolyzed by typical strains but not by variety inulinaceus. Esculin is hydrolyzed but not sodium hippurate.

Nitrites not produced from nitrates.

Ammony not produced from 4 per cent

Ammonia not produced from 4 per cent peptone.

Temperature relations: Optimum temperature 35°C When freshly isolated, maximum 45°C. No growth at 22°C or below Survives 60°C for 30 minutes, but not 65°C.

Chemical tolerance: 2 per cent NaCl growth, 4 per cent NaCl no growth, 65 per cent NaCl no growth. Final plf in glucose broth 45 to 4.0. No growth at pH 96 May tolerate 001 per cent methylene blue but not 0.1 per cent. Tolerant of bile and not soluble.

Action on blood: Not hemolytic; the changes exhibited vary from greening (alpha) to no observable change (gamma).

Soluble hemolysin: Absent.

Toxin: Absent.

Serology: Some cross reaction with Lancefield Group D (Sherman, Jour Bact, 55, 1938, 81).

Facultative anaerobe.

Distinctive characters: Greening or no change in blood, a higher maximum temperature of growth than Streptococcus saluarius and distinctly higher thermal resistance (60°C for 30 minutes); hydrolysis of starch and usually ferments anabinose and sometimes mannitol.

Source: Saliva, feces and intestinal contents of cattle; milk of cows; sometimes abundantly present in human feces (Bargen's coccus) in health and disease. The variety inulinaceus is sometimes abundant in the bovine throat.

Habitat: Bovine mouth and alimentary tract where it is the predominating strep-

tococcus.

9. Streptococcus thermophilus Orla-Jensen. (Maelkeri-Bacteriologi, 1916, 37; The Lactic Acid Bacteria, 1919, 136.) From Greek thermus, heat; philus, loving.

Spheres: 0.7 to 0.9 micron, with pointed ends, occurring singly and in short chains.

Gram-positive.

Gelatin stab: No liquefaction.

Nutrient agar: Small, pin-point, gray, circular colonies. In streak cultures growth is scanty, beaded and gray. Fastidious in nutritive requirements needing appropriate carbohydrates added to penon-infusion media (especially lactose and sucrose). Viability on laboratory media low.

Broth: Fine granular sediment; usually in very long chains, especially at

45°C.

Litmus milk · Acid, curdled, followed by partial reduction of the litmus.

Acid from glucose, fructose, laclose, and sucrose; seldom ferments raffinose and arabinose. No acid from maltose, dextrin, inulin, glycerol, mannitol, sorbitol or salicin.

No hydrolysis of sodium hippurate or esculin. Starch may be hydrolyzed on a favorable medium.

Ammonia not formed from 4 per cent

peptone.

Temperature relations: Optimum 40° to 50°C. Minimum 20°C. No growth

to 56°C. Minimum 20°C. Ao grossia at 53°C. Survives 60° and 65°C for 30 minutes. Thermal death point 72° to 74°C. Chemical tolerance: Extremely sensi-

Chemical tolerance: Extremely tive to salt, no growth with 2 per cent, 4 per cent and 6.5 per cent NaCl. Final pli in glucose broth 4.5 to 4.0. No growth

at pH 96. Not tolerant of 001 per cent and 0.1 per cent methylene blue.

No action on blood

Serology . No cross reaction with Lancefield Group D (Sherman, Jour Baet . 35. 1938, 81).

Facultative anaerobe.

Distinctive characters High growth temperature (50°C) and heat resistance (60° to 65°C). Inability to ferment maltose and salicin. Inhibited by 2 per cent NaCl Nutritive requirements in medium

Source: Milk and milk products Used as a starter in making Swiss cheese

10. Streptococcus equinus Andrewes and Horder. (Lancet, 2, 1906, 712) From Latin equinus, of horses.

Spheres: Occurring in short chains, the chains are longer in broth than in milk and some cultures give extremely long chains in broth. Gram-positive.

Gelatin stab: Little or no growth at

20°C. Not liquefied. Litmus milk: No visible change, grows poorly (with 2 per cent added glucose there is little reduction of litmus).

Acid from glucose, fructose, galactose, maltose and usually from sucrose and salicin; raffinose and inulin are seldom fermented; arabinose, vylose, lactose, mannitol and glycerol are not fermented The salicin negative strains correspond to Streptococcus ignavus Holman, Jour. Med Res , 34, (N. S. 29), 1916, 377

Starch is not hydrolyzed under ordipary conditions of test (poured plate); it may be hydrolyzed by streak cultures on s very favorable medium. Sodium hippurate is not split. Esculin is bydrolyzed slowly, failure in three days, becomes positive in seven

Ammonia not produced from 4 per cent pentone.

Temperature relations: Minimum 21°C. Growth at 45°C, seldom at 47°C, and no growth at 48°C. Sometimes survives 60°C for 30 minutes.

Chemical tolerance: Growth in 2 per cent NaCl but not in 4 per cent and 6.5 per cent. Final pH in glucose broth 4.5 to 4.0; no growth at pH 9 6. Some strains tolerate 0.01 per cent but none tolerate 0.1 per cent methylene blue.

Action on blood, Greening (alpha on horse blood) varying to weak but definite No hemolysis Serology unknown, but no cross reac-

tion with Lancefield Group D (Sherman, Jour. Bact., 35, 1938, 81). Facultative anaerobe.

Distinctive characters: Minimum tem-

perature of growth (20°C) and high maximum temperature of growth (47°C); poor growth in milk, even with added glucose: failure to ferment lactore

Sources. Human and bovine feces; human mouth, urine and inflammatory exudates (pathogenicity not established). Andrewes and Horder (loc cit ) failed to find it in feres of fox and stoot.

Habitat: Predominating organism in the intestine of horses.

11. Streptococcus lactis (Lister) Löh-(Bacterium lactis Lister, Quart. Jour Micro. Sci., 13, 1873, 380; 18, 1878, 177, Löhnis, Cent f Bakt, II Abt . 22. 1909, 553 ) From Latin Igc, milk.

The following organisms are generally regarded as identical with Streptococcus lactis Löhnis See Breed, in Jordan and falk, The Newer Knowledge of Bacteriology and Immunology, Chicago, 1928,

383 Streptococcus acid: lactic: Grotenfelt, Fortschr. d Med., 7, 1889, 121; Micrococcus acidi paralactici Neneki and Sieber, Monatschr. f. Chem., 10, 1889, 532; Bacillus No. 19, Adametz, Landw. Jahrb., 18, 1889, 227; Eine bestimmte Bacterienart, Günther and Thierfelder, Arch. f. Hyg., 25, IS95, 161; Bacillus acidi Inchei Laten, Storrs Agric. Laper. Sta. Conn , Ann Rep for 1896, 1897, 41 (not Milchafurebacterium, Hueppe, Mitt. d. kais. Gesundheitsamte, 2, 1881, 310, which is Boeillus acidi lactici Zopl, Die Spaltpilze, 3 Aufl., 1885, 87); Bacterium gunthers Lehmann and Neumann, Bakt. Diag., 1 Auff . 2, 1896, 197; Bacterium

lactis acidi Leichmann, Cent. f. Bakt., II Abt., 2, 1896, 777 (not Bacterium lactis acidi Marpmann, Erganzungshefte Cent. allgem. Gesundheitspflege, 2, 1886. 117); Der ovaler Coccus, Freudenreich. Cent. f. Bakt., II Abt , 1, 1896, 168; Bacillus lacticus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 356; Bacterium lacticus Chester, Del. Agr. Exp Sta., 9th Ann. Rept., 1897, 88; Bacillus acıdi paralactici Kozai, Ztschr. f. Hyg., 31, 1899, 372; Streptococcus paralacticus Migula, Syst. d. Bakt., 2, 1900, Bacterium Iacticum Migula, Syst. d. Bakt , 2, 1900, 405, Bacterium truncatum Migula, Syst. d Bakt , 2, 1900, 407 (Bacillus No. 19 of Adametz: Bacterium punctatum Chester, Man. Determ. Bact ... 1901, 147; not Bacterium truncatum Chester, ibid , 157; not Bacterium truncatum Chester, ibid., 195); Streptococcus grotenfeltii Chester, Manual Determ. Bact , 1901, 67: Lactococcus lactis Beijerinck, Arch. Neérl. d. Sci. Exact et Nat , Sér. II, 7, 1901, 213; Streptococcus lacticus Kruse, Cent. f. Bakt., I Abt., Orig , 34, 1903, 737, Streptococcus guntheri Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 242; Bacillus lactis acidi Sewerin, Cent. f. Bakt., II Abt., 22, 1908, 8 (not Bacillus lactis acidi Marpmann, loc cit , 120, nor Leichmann, loc. cit, 778), Bacterium leichmanni Wolff, Cent. f. Bakt , II Abt., 24, 1909, 57.

Spheres. Many cells elongated in direction of chain; 0 5 to 1 micron; mostly pairs and short chains, with some cultures long chains. Gram-positive.

Gelatin stab: Filiform to beaded growth. No liquefaction

Nutrient agar colonies: Small, round or oval, grav, entire, slightly raised Streak culture tends to remain as definite colonies throughout, confluent in parts

Glucose broth Turbidity and later sediment

Potato: No visible growth.

Litmus milk. Acid, complete reduction of litmus before curdling. Young cultures

entirely reduced with narrow red band at top which widens with ageing. No digestion and no gas produced, but whey may be expressed.

Acid from glucose, maltose and lactose; variable in arabinose, xylose, maltose, sucrose, mannitol and salicin. No acid from raffinose, inulin, glycerol or sorbitol. Occasional strains have been noted which fail to ferment lactose (Yawger and Sherman, Jour. Dairy Sci., 20, 1937, 83) and others which do ferment raffinose (Orla-Jensen and Hansen, Cent. f. Bakt., II Abt., 86, 1932, 6).

Starch not hydrolyzed. Sodium hippurate may be hydrolyzed and esculin is split.

Ammonia is produced from 4 per cent peptone.

Temperature relations: No growth at 45°C. Some strains survive 60°C for 30 minutes.

Chemical tolerance: Growth with 2 per cent and 4 per cent NaCl but not with 65 per cent. Final pH in broth 45 to 40 No growth at pH 9.6 but grows at pH 92 Tolerates both 0 01 per cent, 0.1 per cent and 03 per cent methylene blue. Bile neither lyses nor inhibits growth.

Action on blood: No hemolysis; may show greening or no action.

Serology: Sherman, Smiley and Niven (Jour. Dairy Sci., 23, 1940, 529) have produced a species-specific group serum for this species. Shattock and Mattick (Jour. Hyg., 43, 1943, 173) have designated this group as Group N. The above authors are in agreement in feeling that their studies indicate a close serological relationship between Streptococcus lactis and Streptococcus cremoris. Toxin not known.

Facultative anaerobe.

Distinctive characters: Growth at 10°C or below and at 40°C but not at 45°C; rapid complete reduction of litmus before curdling milk; growth in presence of 4 per cent but not 6.5 per cent NaCl; ammonia produced from peptone; no growth at pH 96 but grows at pH 92.

Source: Isolated from milk by Lister (loc. cit.), Milk and milk products

Habitat. Not in the udder of cows. Plants may be natural habitat (Stark and Sherman, Jour. Bact., 30, 1935, 639).

Nors: The following may be regarded as varieties of Streptococcus lactis: (1) Streptococcus lactis: (2) Streptococcus lactis: (3) Streptococcus lactis var. maltigenes Hammer and Cordes, Iowa Agr Exp Sta Res Bull. 68, 1921; (2) Streptococcus lactis var anozyphilus Hammer and Baker, Iowa Agr. Exp Sta, Res. Bull. 99, 1926; (3) Streptococcus lactis var. tardus Hammer and Baker, told Also (4) Streptococcus amplolactis; (5) Streptococcus rafinolactis and (6) Streptococcus saccharolactis OrlaJensen and Hansen, Cent. f Bakt, II Abt., 68, 1932, 6.

12 Streptococcus cremoris Orla-Jensen. (The Lactic Acid Bacteria, 1919, 132.) From Latin cremor, thick juice, M. L., cream.

Synonyms: ? Streptococcus hollandicus Wiegmann, in Kramer, Die Bakteriologie in ihren Beziehungen zur Landurtschaft und den Landur. Technischen Gewerben, Wien, 1890; Streptococus lactis B, Ayers, Johnson and Mudge, Jour. Inf. Dis., 34, 1934, 29.

Spheres: 0 6 to 0 7 micron (often larger than Streptococcus (actis), forming long chains, especially in milk, some cultures in pairs. Gram-positive.

Gelatin stab: No liquefaction

Litmus milk. Acid, complete reduction of litmus before curdling with red line at top broadening with age; clot separates with no digestion of casein, milk becomes alimy.

Acid from glucose and lactose, may ferment maltose, salicia and rarely sucrose, raffinose and mannitol Arabinose, xylose, sorbitol, mulin and glycerol are not fermented.

No hydrolysis of starch and sodium hippurate but sometimes esculin

Ammonia not produced from 4 per cent peptone.

Temperature relations: Optimum be-

low 30°C. Minimum 10°C. Maximum 37°C. Maximum 37°C. May survive 60°C for 30 minutes. Thermal death point 65°C to 70°C.

Chemical tolerance Grows with 2 per cent but not with 4 per cent and 6 5 per cent NaCl. Final pH in glucose broth 4 6 to 4 0 No growth at pH 9 6 and 9 2. Tolerates 0 01 per cent and sometimes 0 1

Distinctive characters. Inability to grow at 40°C; reduction of litmus before curding milk; no growth in the presence of 4 per cent NaCl and at pH 9 2; does not grow well on artificial media.

Source Raw milk and milk products; commercial starters in butter and cheese factories. Not known from human and animal sources

The following may be regarded as varieus of Streptococcus ceremora: (1) Streptococcus lectus var. hollandscus Buchana and Hammer, Iowa Agr. Exp. Sta. Res Bull 22, 1915, (2) Streptococcus manuticeremors Orla-Jensen and Hansen, Cent. f. Bakt, II Abt., 88, 1932, 6.

13 Streptococcus faecalis Andrewes and Horder. (Micrococcus ovalis Escherich. Die Darmbakterien, Stuttgart, 1886, 89, Entérocoque, Thiercelin, Compt rend Soc. Biol., Parts, 54, 1902, 1032; Enterococcus protesformis Thiercelin and Jouhaud, Compt. rend. Soc. Biol , Paris, 55, 1903, 686; Andrewes and Horder, Lancet, 2, 1906, 708; Streptococcus faecium and Streptococcus glycerinaceus Orla-Jensen, The Lactic Acid Bacteria, 1919, 139 and 140, Diplococcus enterococcus Neveu-Lemaire, Précis Parasitol Hum , 5th ed , 1921, 18, Streptococcus otalis Lehmann and Neumann. Bakt Diag , 7 Aufl , 2, 1927, 200 and 230; Streptococcus protesformis Hauduroy et al , Dict d Bact Path , Paris, 1937, 520) I'rom Latin faez, dregs, residue; M L, feces, exerement; M L faecalis. fecal

Escherich reclassified his Micrococcus

Litmus milk · Acid; curdled, followed by reduction of litmus.

Acid from glucose, maltose, lactose, and usually salicin and trehalose Raffinose, inulin, sorbitol, arabinose, glycerol not fermented and mannitol and sucrose rarely fermented.

Starch not hydrolyzed. Sodium hippurate and esculin are hydrolyzed.

Ammonia is produced from 4 per cent peptone

Temperature relations: Growth at 10°C. Maximum 50°C. Survives heating for 30 minutes at 62 8°C and usually 65 6°C.

Chemical tolerance: Growth with 2 per cent, 4 per cent and 6 5 per cent NaCl. Final pH in glucose broth 4.5 to 4.0. Growth at pH 96. Tolerates 0.01 per cent and 0 1 per cent methylene blue.

Action on blood: Active hemolysis of beta type (horse, human and rabbit blood); persistent after 5 years culture on media without blood.

Toxin unknown. Non-pathogenic for mice, rabbits and guinea pigs

Serology · Lancefield's Group D (Sherman, Jour. Bact, \$5, 1938, 81).

Facultative anaerobe

Distinctive characters . Growth at 10°C and 45°C; beta hemolysis; failure to ferment sucrose and mannitol, resistance to 60°C for 30 minutes, tolerance of 0.1 per cent methylene blue and 65 per cent NaCl.

Source Forty strains were isolated from spray process milk powder.

Habitat: Human intestine, milk and milk products.

\*17. Streptococcus anaerobius Krönig emend Natvig. (Kronig, Zent. f. Gyn. 1895; Natvig, Arch. f. Gyn., 1905, 76.) From Greek an, without, aer, air; bios, life; M. L., anaerobic.

Heurlin (Bakt. Unters. d. Keimgehaltses im Genitalkanale d. fiebernden Wöchnerinnen. Helsingfors, 1910, 122-127) recognizes the following varieties of Streptoanaerobius S. anaerobius vulgaris, S. anaerobius typ. vulgaris, S.

anaerobius gonoides. S. anaerobius (Wegelius No 28), S. anaerobius micros (Lewkowicz), and S. angerobius carduus

Description according to Prévot. Ann. Sci. Nat., Sér. Bot., 15, 1933, 180.

Spheres: Average size 08 micron, occurring in chains. Non-motile. Grampositive.

Gelatin: No liquefaction.

Semi-solid agar (Veillon): After 48 hours colonies 1 to 2 mm in diameter, very lenticular. Gas regular. Agar slightly acidified.

Martin broth: Rapid growth. No turbidity. Sediment in 24 hours. Medium slightly acidified. Feeble production of gas. Slight fetid odor.

Martin glucose broth: Very abundant growth. Gas fetid, inflammable, no H.S Very marked acidification.

Peptone water: Abundant flocculent growth. Gas produced at expense of peptone. Medium not acidified. Neither indole nor H2S produced.

Meat and liver broth: Very abundant growth. Much gas produced which contains CO. and He.

Milk: No acid. No coagulation.

Cooked protein (egg white, meat, liver, fibrin and serum) not attacked. Fresh fibrin and fresh organs partially disintegrated with blackening, abundant gas, very fetid odor due in part to H1S.

Serum broth: Abundant gas and fetid odor.

Neutral red broth: Changed to fluorescent yellow.

Acid from glucose, fructose, galactose, sucrose and maltose. Mannitol and arabinose sometimes fermented.

Optimum pH 6.0 to 8.0.

Temperature relations: Optimum 36° to 38°C. Grows at 26°C, but not below 22°C. Survives 5 minutes at 60°C or two minutes at 80°C Killed in ten minutes at 80°C.

Pathogenic.

Strict anaerobe.

Distinctive characters: Very peptolytic; gas produced in peptone water with Differs from destruction of the peptone

See footnotes, p. 308. Reviewed by Dr. Ivan C. Hall.

Streptococcus foetidus by being morphologically like a typical streptococcus. Differs from Streptococcus putridus by its physiology, bread crumb-like growth, and the production of gas in all media

Source: Isolated in cases of putrefactive gangrene; war wounds, uterus, lochia and blood in puerperal infections, appendicitis; pleurisy; and amniotic fluid

Habitat: Mouth and intestines Cavities of man and animals, especially the vagina. Can invade all tissues

18 Streptococcus foetidus (Veillon) Prévot. (Micrococcus foetidus Veillon, Compt. rend. Soc. Biol. Paris, 45, 1893, 867; not Streptococcus foetidus Migula, Syst. d. Bakt , 2, 1900, 38; Prévot, Ann Sci Nat., Sér Bot., 15, 1933, 189 ) From Latin foetidus (better fetidus), stinking

Large spheres: 08 to 10 micron, occurring normally in short chains, also in tetrads, double or zig-zag chains. Nonmotile. Gram-positive

Gelatin: No liquefaction.

Semi-solid agar (Veillon): Slow growth At first punctiform; small colonies 1 to 1 mm in diameter, growing 1 to 2 cm below the surface, regular, thick, lenticular, opaque. Gas bubbles produced

Blood agar; Small brownish hemopeptic zone around the colonies

true hemolysis.

Martin broth, Poor growth No turbidity. Flakes form on wall of tube, but rapidly settle to the bottom Little or no gas. Very faint fetid odor.

Martin glucose broth. Good growth No turbidity. Gas fetid, inflammable

Meat and liver broth . Rapid, abundant growth. Abundant eas Strong fetal odor.

Milk: No acid. No coagulation.

Peptone water. Gas production feeble. Indole not formed. Neutral red broth changed to fluores-

cent yellow. Fresh organs become green, then

blacken. Much gus produced containing II.S. later the organs are gradually disinfermentation.

Cooked protein not attacked

Acid and gas from glucose, fructose, galactose and sucrose No acid from lactose, maltose, arabinose, glycerol, mannitol, dulestol or starch.

tegrated; partial bioproteolysis and H-S

Temperature relations Optimum 36° to 38°C. Feeble growth at 26°C. No growth below 22°C. Killed in one hour at 60°C or in ten minutes at 80°C.

Optimum pH 6 5 to 8 0. Pathogenic for guinea pigs and mice

Strict anaerobe.

Common in fetid suppurations and autogenous gaugrenous processes.

Source · First isolated from a fatal case Ludwig's angina Perinephritic phlermon; the fetid pus from Bartholin's gland, gangrene of the lung; appendicitis.

Habitat Mouth, intestine and vagina of man and animals.

18a Streptococcus foetidus var buccalis (Einen Micrococcus der Mundhohle, Ozaki, Cent f. Bakt., I Abt., Orig., 76, 1915, 118; Micrococcus buccalis Bergey et al., Manual, 1st ed , 1923, 69. Prévot, Ann Sci. Nat., Sér. Bot., 15, 1933, 193) From mouth

19 Streptococcus putridus Schottmuller emend. Prévot (Schottmuller, Mitteil a d Grenzgeb d. Med Chirurg . 21, 1910, 450, Prévot, Ann. Sci Nat , Sér Bot , 15, 1933, 170, 181 ) From Latin putridus, rotten, decayed

Synonym Streptococcus putrificus Schottmüller, Münch med Wochnschr.,

68, 1921, 662 Spheres Average size 08 micron, oc-

curring in chains. Gram-positive. Gelatin: No liquefaction

Semi-solid agar (Veillon): More or less lenticular, colonies 1 to 2 mm in diameter. No gas produced.

Blood agar: A blackish-brown hemopeptic zone is produced around the colonies, with fetid grs (II-S). Colonies become brownish, sometimes blackish.

Martin broth: In 6 to 8 hours uniform

turbidity which does not precipitate completely. No gas. Little odor.

Martin glucose broth: Rapid abundant growth. Uniform turbidity. Sediment. No gas. Slight fetid odor. Black pigment in the sediment.

Meat and liver broth: Very abundant growth, very marked putrid odor. Incomplete sedimentation.

Peptone water Sparse growth. Neither gas, odor, H<sub>2</sub>S nor indole.

Milk: No acid No coagulation. Cooked protein not attacked.

Deep blood agar Agar is broken by the gas (H-S).

Fresh blood broth Abundant gas which contains a large amount of H<sub>2</sub>S. Blood blackens rapidly, has typical putrid odor

Fresh fibrin broth: The fibrin is broken up and partially digested.

Neutral red changed to fluorescent yellow.

Lead media blackened.

Acid from glucose, fructose and maltose Acid sometimes produced from sucrose, mannitol and calactose

Optimum pH 7.0 to 8 5.

Temperature relations: Optimum 36° to 38°C. Growth feeble at 28°C. No growth below 22°C. Killed in ten minutes at 80°C

Pathogenic when grown in media with fresh tissue and body fluids

Strict anaerobe.

Distinctive characters. Putrescence but absence of gas in ordinary media; presence of gas and H<sub>2</sub>S in media with fresh tissue or body fluids.

Source. Normal and fetid lochia, blood in puerperal fever, gangrenous appendicitis, gangrene of the lung, in gas gangrene, gangrenous metastases; war wounds; osteomyelitis; and from anniotic fluid. Found in sea water by Montel and Mousseron (Paris Médical, 1929)

Habitat: Human mouth and intestine and especially the vagina.

20. Streptococcus lanceolatus Prévot. (Coccus lanceolatus anaerobius Tissier,

Compt. rend. Soc. Biol. Paris, 94, 1928, 447; Prévot, Ann. Sci. Nat., Sér. Bot., 16, 1933, 173 and 193; not Strephococcul lanceolatus pasteuri nor Strephococcul lanceolatus Gamalela, Ann. Inst. Past., 2, 1888, 440; not Strephococcus lanceolatus Gamilela, Ann. past. Past., 2, 1889, 440; not Strephococcus lanceolatus Saito, Arch. f. Hyg., 75, 1912, 121, Although Prévot's name is invalid, it is used until further comparative studies have been made. From Latin lanceolatus, having a little lance, pointed.

Large ovoid cells: 1.2 to 1.4 micross with pointed ends, occurring in short chains in culture and in pairs in evudates. Non-motile. Gram-positive.

Gelatin: No liquefaction.

Deep agar colonies: Very large, lenticular. Abundant gas produced which breaks up the medium.

Peptone broth: Uniform turbidity. Granular, glairy sediment.

Peptone water: Good growth Gas

Milk: No change.

Protein not attacked.

Hydrolyzed albumen reduced to CO., (NH<sub>4</sub>)<sub>2</sub>CO<sub>2</sub> and NH<sub>2</sub>.

Acid from sucrose, glucose and starch No acid from lactose. (Butyric, valerianic and acetic acid are produced, in the proportions 2:1:trace, from glucose and sucrose.)

Non-pathogenic for laboratory suimals.

Optimum temperature 37°C.

Strict anaerobe.

Distinctive characters: Proteolyte and saccharolytic; produces aumonia from hydrolyzed proteins; butyric, valerianic and acetic acid produced from hexoses. No II-S produced.

Source: From human feces in a case of

Habitat: Putrefying materials.

21. Streptococcus micros Prévot (Streptococcus anaerobius micros Leviucz, Arch. Méd. Exp., 13, 1901, 615; Prévot, Ann. Sci. Nat., Sér. Bot., 16, 193, 193; also see Weiss and Mercado, Jun. Inf. Dis., 62, 1933, 181.) From Gret micrus, small (old spelling, micros).

Very small spheres: 0.2 to 0.4 micron. occurring in long chains or in pairs motile Gram-positive

Galatin . Poor grouth No. ficute.

faction

Semi-solid 0077 (Veillon) · Slow growth colonies at first nunetiform, hecoming lenticular and later forming procorear into the medium. Average size 0.5 to 1.0 mm in diameter, some reach 2 to 3 mm growing 2 or 3 cm below the surface

Blood agar: No hemolysis No hemo-

pentalysis.

Martin broth: Slight particulate turhidity a high sloa ly settles

Meat and liver broth Rand growth

Abundant sediment.

Pentone water: Powdery sediment Medium not acidified No andole formed Neutral red broth: Changed to fluores-

cent vellow. Milk: Grous with difficulty. No acid

No congulation.

Acid produced moully from glucose, fructose, galactose, sucrose and maltose. No acid from lactose, arabinose, glycerol. mannitol, mulin and starch

Protein not attacked.

Optimum pH about 7 0.

Ontimum temperature 36° to 38°C No growth at 22°C. Killed in a quarter of an hour at 60°C.

Non-nathogenic for mice.

No toxin and no hemolysin. Strict anaembe

Distinctive characters Neither Ess nor fetid odor produced. Small size Source Gingrene of the lung, lochin and uterus in puerperal sepsis, ap-

pendicitie Habitat: Mouth and intestine of man and animals

22 Streptococcus parvulus Weinberg, Nativelle and Privot (Streptocecus parrulus non liquefaciens Repaci, Compt rend Soc. Biol , Paris, 63, 1910, 528. Weinberg, Nativelle and Privot, Les Microbes Anaérobies, 1937, 1011, not Streptococcus parrulus Levinthal, Cent

f. Bakt., I Abt., Orig., 103, 1928, 195 ) From Latin pareulus, very small, minute Small enhance: Avenue eize 03 to 0 t

micron occurring in short chains come times mirs Non-motile Gram-:positive

Gelatin : At 37°C slow growth culture at bottom of the tube: no gas No liquefaction

Deep clucose agar colonies: After 48 hours very tiny, lenticular, whitish. Old colonies become blackened. No ras prohearth

Broth Renid turbidate Sediment forms in 5 or 6 days as a whitish, mucous mass which closes the fluid Faint disagreeable odor

Indole not formed

Milk Cognitation in 21 hours

Egg white not attacked

Feebly attacks plucose and lactose Dues not attack sucrose, galactose and dextron

Ontinum temperature 37°C. No growth at room temperature. Will grow at 41°C

Street angembe

Distinctive characters Differs from Strentoeoccus micros by its black colonies. congulation of mulk and its feeble saccharalytic power Differs from Strentococcus intermedius by its black colonies. the smallness of its elements, feeble saccharmlytic power and the viscous sediment in broth

Source Respiratory tract

Habitat Unknown.

Veillon and Remei identified this orennism as Streptococcus micros, but Weinberg, Nativelle and Prevot consider it as a distinct species, although rare

23 Streptococcus Intermedius l'révot (Ann. Inst. Past . 39, 1925, 439.) From Latin intermedius, intermediate.

Description taken in part from Privot. Ann Sci Nat , S'r Bot , 15, 1933, 197, Spheres. 05 to 07 micron, very long chains in culture. Non-motile Grampositive.

Gelatin: Poor growth. No liquefaction.

Semi-solid agar (Veillon): After 24 hours colonies 1 to 2 mm in diameter, regular, lenticular; sometimes with complex processes.

Blood agar: No change or slight greening.

Martin broth: Rapid growth. Uniform turbidity which slowly settles.

Martin glucose broth; Abundant growth, Abundant sediment. Medium strongly acidified.

strongly acidified.

Peptone water: Particulate sediment.

Milk: Very acid. Coagulated in 24

hours, without retraction of clot and not peptonized. Serum broth (1:2). Rapid growth.

Congulation by acidification.

Proteins not attacked.

Neutral red broth: Changed to fluorescent yellow.

Acid from glucose, fructose, galactose, maltose and lactose. Acid from sucrose by some strains. The acid produced is lactic acid No acid from arabinose, glycerol, mannitol, dulcitol, inuln or starch.

Optimum pH 6 0 to 8.5.

Temperature relations: Optimum 36° to 38°C Poor growth at 26°C. No growth below 22°C. Killed in half anhour at 70°C or in ten minutes at 80°C.

Pathogenic for guinea pigs and mice, causing small abscesses; sometimes kills

in 48 hours.

No toxin and no hemolysin.

Strict anaerobe.

Distinctive characters: Strongly acidifies media Coagulates milk.

Source: Lochia and uterus in puerperal sepsis; gangrene of the lung; pleurisy; bronchiectasis; appendicitis.

Habitat: Human respiratory and digestive tracts and vagina.

24. Streptococcus evolutus Prévot. (Streptococcus Sch., Gráf and Wittneben, Cent. f. Bakt., I Abt., Orig., 59, 1925, 443; Streptococcus Schwarzenbeck, Ford, Textb. of Bact., 1927, 455; also see Weiss and Mercado, Jour. Inf. Dis., 62, 1938, 181.) From Latin evolutus, unrolled.

Description taken in part from Prévot, Ann. Sci. Nat., Sér. Bot , 15, 1933, 199.

Spheres: 0 7 to 1.0 micron, average 07 micron, occurring in pairs or in short and long chains. Pleomorphic. Often appear as short ovoid rods with rounded ends. Gram-positive.

Gelatin: Liquefaction.

Deep agar colonies: Lenticular or rosettes. Growth occurs about 1 cm beneath the surface; after a transfer the second generation may show a ring of growth in the middle of this sterile zone. This is the characteristic alternate zone appearance. Colonies usually become brownish with age.

Glucose broth: Abundant growth, resembling bread crumbs. Medium strongly acidified (pH 5). A small quantity of lactic acid produced.

Peptone broth: Rapid growth. No general turbidity. Precipitating flocu-

lent growth on the wall of the tube Blood agar: No change, sometimes

greening.
Peptone water: Flocculent growth
No turbidity. Indole not formed.

Litmus milk: Acid. Curdled in 24 hours, clot retracts and fragments Slight peptonization with some stmiss. Strongly acid in glucose, fructose,

galactose, sucrose, lactose and maltose Arabinose sometimes fermented.

Egg white not attacked.

Pathogenicity: Most strains not pathogenic, some produce slight local swelling subcutaneously with little pus in guinea pigs and mice.

Optimum pH 6.0 to 8.5.

Optimum temperature 36° to 38°C.

No growth below 22°C.

Strict anaerobe at first, becoming facultative with subsequent transfers.

Viability short aerobically and several months anaerobically.

onths anaeropically.

Distinctive characters: Growth in al-

ternate zones in agar. Strict anaerobe at first, later microaerophilic

Source: Skin abscess; appendicitis Habitat: Respiratory tract, mouth, vagina.

Appendix I: Descriptions of poorly defined species, the taxonomic relationships of which are not clear.

 Streptococcus sp. Long and Bliss (Minute beta hemolytic streptococcus, Long and Bless, Jour Evp Med, 60, 1934, 619; Long, Bliss and Walcott, ibid, 633.)

Minute cocci, half to two-thirds the size of Streptococcus pyogenes, occurring singly, in pairs, short chains and in small and large masses. Gram-positive, but may decolorize readily.

Blood agar: Very minute colonies 18 to 30 microns, surrounded by a marked area of hemolysis (beta), easily visible before the colony is seen by naked eye, 4 to 10 times the diameter of the colony Under the microscope colonies are finely granular, may appear wrinkled and crenated. Colonies become visible after

48 to 96 hours incubation and relative area of hemolysis is 3 to 4 times diameter of colony Gelatin. Not liquefied. Glucose broth: Growth diffuse,

abundant. Litmus milk Not curdled, litmus not

reduced.
Acid from glucose, maltose and su-

erose, may or may not attack lactose, trehalose and salicin No acid from arabinose, raffinose, inulin, glycerol, mannitol or sorbitol

Does not hydrolyze sodium hippurate and starch. Esculin is hydrolyzed

Ammonia is produced from peptone.

Temperature relations No growth at 10°C, very rarely growth at 45°C. Does not survive 60°C for 30 minutes.

Chemical tolerance Does not tolerate 65 per cent NaCl Final pII in glucose broth 54 to 46; no growth at pH 9.6 Methylene blue 01 per cent not tolerated No growth on 40 per cent bile-blood agar Action on blood: Hemolysis marked before colony is visible. May not produce soluble hemolysin by ordinary methods but does so abundantly by appropriate methods.

Fibrinolysin: No solution of human fibrin.

Serology: Constitutes Group F of Lancefield and Hare (Jour Exp Med , 61, 1935, 335) Four serological types within the group (Bliss, Jour Bact , 55, 1937, 625).

Aerobe, facultative anaerobe,

Acrose, incurative americo.

Source. Human throat in health and disease, accessory sinuses, abscesses, yagung skip and feese.

Habitat: Human upper respiratory

2 Streptococcus sp. Long and Bliss (Group II, Long and Bliss, Jour. Exp Med , 60, 1934, 633; Group G, Lancefield and Hare, Jour. Exp Med., 61, 1935,

346, Blass, Jour. Bact., 53, 1937, 625.)
Probably identical with Streptococcus
anginosus Andrewes and Horder (Lancet,
2, 1906, 712) but probably other serologceal types are included in this group
(Sherman, Bacteriological Reviews, 1,
1937, 40)

Spheres: Gram-positive.

Gelatin Not liquefied.

Litmus milk. Acid, may be curdled, not reduced

Acid from glucose, maltose, sucrose,

trehalose and saliein, usually acid from lactose, and may or may not from raffinose and glycerol. No acid from srabinose, inulin, mannitol or sorbitol

Sodium hippurate usually not hydrolyzed May hydrolyze starch and esculus.

Ammonia is produced from peptone

Temperature relations: No growth at 10°C and usually not at 45°C. Does not survive 60°C for 30 minutes

Chemical tolerance: Does not tolerate 65 per cent NaCl. Final pH in glucose broth 60 to 46; no growth at pH 96 Methylene blue 0.1 per cent not tolerated. May grow on 40 per cent bileblood agar, growth in 10 per cent bile.

Action on blood: Hemolytic (beta) with a wider zone than minute beta hemolytic streptococcus. Soluble hemolysin formed.

Fibrinolysis: May dissolve fibrin, certain strains strongly, others

weakly.

Serology: Constitutes Lancefield's and Hare's Group G. Bliss (loc. cit.) has shown serological Types I and II within the group. May include serological Type 16 of Griffith (Jour. Hyg. 84, 1934, 542). Those resembling Streptococcus anginosus seem to form a homogeneous type; others seem unrelated to it. Aerobic, facultative anaerobe.

Source. Human nose, throat, vagina, skin and feces in health. In human disease in puerperal fever with staphylococcus. Throat of normal domestic animals and in animal infections probably as secondary invaders.

Habitat: Human upper respiratory tract and vagina. Possibly throat of domestic animals.

3. Streptococcus sp. Brown, Frost and Shaw. (Jour. Inf. Dis , 38, 1926, 381; Lancefield, Jour Exp. Med., 57, 1933, 571.)

Belongs to Lancefield Group E.

Gelatin: Not liquefied Litmus milk. Not curdled and not reduced

Acid from glucose, lactose, trehalose and sorbitol; may form acid from sucrose, glycerol, mannitol and saliein. No acid from arabinose, raffinose or inulin.

No hydrolysis of sodium hippurate, may hydrolyze starch and esculin.

Ammonia is produced from peptone.

Temperature relations: No growth at 10°C and 45°C. Does not survive 60°C for 30 minutes

Chemical tolerance: Does not tolerate 6,5,per cent NaCl. Final pH in glucose Cent. 18 29 42; no growth at pH 96. 443: Streptdue 0.1 per cent not tolerated Textb. of F

and not reduced. No growth on 40 per cent bile-bloodagar, nor on 10 per cent bile.

Action on blood: Very hemolytic; strains reported by Plastridge and Hartsell (Jour. Inf. Dis., 61, 1937, 110) weakly hemolytic, Streptolysin produced and outstandingly acid stable (Todd, Jour. Path. and Bact , 59, 1934, 299).

Fibrinolysin: No solution of human fibrin.

Serology: Lancefield Group E, some cross reaction with Group C.

Aerobe, facultative anaerobe.

Source: Certified milk: bovine udder. Habitat: Probably in udder and dairy products.

4. Streptococcus sp. Hare. (Group H. Hare, Jour. Path. and Bact., 41, 1935, 499.)

Spheres: Gram-positive.

Blood agar: Small colonies, 07 to 09 mm, smooth surface, greenish color tending to blacken, hard, almost gritty and adherent to the medium. Hemolysis seldom complete except on Brown's horse blood agar. On boiled blood agar definite greening and so different from Groups E, F and K.

Litmus milk: Not curdled and not reduced.

Acid from glucose, maltose, sucrose, raffinose and salicin; acid may be formed from lactose and trehalose. No acid from arabinose, inulin, glycerol, mannitol or sorbitol.

No hydrolysis of sodium hippurate and starch, but may hydrolyze esculin.

Ammonia may or may not be produced from peptone.

Temperature relations: No growth at 10°C. Growth at 45°C. May survive 60°C for 30 minutes.

Chemical tolerance: Does not tolerate 6.5 per cent NaCl. Final pH in glucose broth 5.0 to 4.5; no growth at pli 96

Methylene blue 0.1 per cent not tolerated No growth on 40 per cent bile-blood agar. Action on blood: Hemolysis incomplete

and some greening. No soluble hemolysin.

Fibrinolysin; No solution of human fibrin.

Serology: Group H.

Aerobe, facultative anaerobe Source: Human throat and feces Habitat: Human throat.

5. Streptococcus sp. Hare (Group K, Hare, Jour, Path. and Bact, 41, 1935, 499)

Spheres · Gram-positive.

Blood agar: Colonies 08 to 13 mm, moist and transparent, with crenated edges. Incomplete hemolysis and no alpha-prime appearance.

Acid from glucose, lactose and salicin; may form acid from trehalose (doubtful) No acid from mannitol or sorbitol.

Does not hydrolyze sodium hippurate. Chemical tolerance: Final pH in glucose broth 5 I to 5 4 Does not grow on 10 per cent and 40 per cent bile-blood agar.

Action on blood: Incomplete hemolysis; does not produce soluble hemolysin. Doubtful if truly hemolytic streptococcus.

Fibrinolysin: Does not dissolve human fibrin.

Serology · Group K

Aerobe, facultative anaerobe.

Source: Human throat.

Habitat: Human throat No indication of relation to disease.

6 Streptococcus acidominimus Ayers and Mudge. (Ayers and Mudge, Jour Inf. Dis, 51, 1922, 40; 53, 1923, 155.) From M. L., derived to mean a minimum amount of acid.

Description taken from Smith and Sherman, Jour. Inf. Dis, 65, 1939, 301 Spheres: Generally occur in short chains. Gram-positive.

Gelatin stab: Filiform, beaded growth. No liquefaction.

Plain nutrient agar: Small round white colonies

Acid from glucose, lactose and sucrose. May form said from maltose, trehalose, and mannitol. Sorbitol and salten usually are not fermented. No acid from arabinose, xylose, raffinose, inulin and elycerol.

Sodium hippurate is hydrolyzed but

Carbon dioxide is produced from a 4 per cent peptone-infusion broth.

Litmus milk: Little or no visible change.

Ammonia is not produced from peptone.

peptone.
Temperature relations: No growth at

10°C. A few cultures grow at 45°C. Do not survive 60°C for 30 minutes. Chemical tolerance: No growth in 01

per cent methylene blue Growth in 2 per cent but not in 65 per cent NaCl. Final pH in glucose broth 6.5 to 56 No growth at pH 96.

Action on blood: No hemolysis, slight greening (alpha).

Serology: Negative reaction with serums representing Lancefield groups A, B. C. D. E. F and G.

Facultative anaerobe.

Distinctive character: Small amount of acidity developed in fermentation tests.

Source: Originally 12 cultures were isolated from freshly drawn milk. Also found in bovine vagina, occasionally inthe udder, and on the skin of calves Habitat. Known to occur abundantly

in the bovine vagina.

The relationship between Streptococcus ubers Diernhofer and other similar atreptococci is not yet entirely clear. Smith and Sherman (Jour. Inf. Dis., 65, 1939, 301-305) at one time thought that Streptococcus uberis and Streptococcus acidominimus might be identical. Others have regarded Streptococcus ubers as identical with Group III, Minett (Proc. 12th Internat. Vet Cong., 8, 1931, 511).

Brown (Proc. 3rd Internat. Cong. for Microbiol., 1940, 173) describes a new species, Streptococcus lentus (not Streptococcus lentus Lehmann, Deutsch. Arch f. klin. Med., 150, 1926, 144) which belongs to serological group E. He states that a few strains that produced the alpha appearance in blood agar corresponded culturally with Strentoccus uberis.

Later Sherman (personal communication) had an opportunity to determine the serological group of several cultures of Streptococcus wheris carefully identified by R B. Little and found them to belong to Group D. While their characters were not exactly the same as the conventional Streptococcus faccalts, he feels that these cultures of Streptococcus wheris were only a variant type of Streptococcus faccalts.

Appendix II.\* The following species of streptococci are listed chiefly because of their historical interest. In many cases the original cultures are lost and their exact taxonomic relationships have not been determined.

Bacterium acetylcholini Habs. (Cent. f. Bakt., II Abt., 97, 1937, 194.) From ensilage. Regarded as a stable type of Entercopecus

Diplococcus bombycis Paillot. (Annales des Épiphytics, 8, 1922, 131.) From the silkworm (Bombyx mori).

Diplococcus liparis Paillot (Annales des Épiphyties, 8, 1922, 122) From larvae of the gypsy moth (Porthetria (Lymantria) dispar)

Diplococcus lymantriae Paillot. (Compt. rend. Acad Sci., Paris, 164, 1917, 526.) From larvae of the gypsy moth (Porthetria (Lymantria) dispar).

Diplococcus metolonthae Paillot. (Compt. rend. Soc. Biol., Paris, 69, 1917, 57; Annales des Épiphyties, 8, 1922, IIS) From diseased larvae of cockchafers (Metolontha metolontha).

Diplococcus pierus Paillot. (Annales des Épiphytes, 8, 1922, 128.) From diseased caterpillars of the cabbage butter-fly (Pierus brassicae).

Diplococcus scarlatinae sanguinis

Jamieson and Edington. (Brit. Med. Jour., 1, 1887, 1265) From the desqua-

mation and blood of scarlet fever patients
Enterococcus citreus Stutzer and Wsorow. (Cent. f. Bakt., II Abt., 71, 1927,
117.) From normal pupae of a moth
(Euxoa secelum).

Lactococcus agglutinans Plevako and Bakushinskaia. (Microbiology (Russian), 4, 1935, 523; abst. in Cent. f. Bakt, II Abt., 94, 1936, 64.) Agglutinates baker's venst.

Streptobacillus malae Goadby. (Jour. State Med. London, 30, 1922, 417; Strepto-eoccus malae Thomson and Thomson, Ann. Pickett-Thomson Res. Lab, 5, 1920, 22.) From the mouth. An aberrant streptococcus.

Streptococcus abortus-equi Hauduroy et al. (Streptococcus abortus equi Ostertas, Monatsh. f. Tierheilk., 12, 1900, 38; Hauduroy et al., Dict. d. Bact. Path, Paris, 1937, 508.) From aborting mares

Streptococcus acidi-lactic Chester. (Sphaerococcus acidi lactici Marpman, Ergānzungshefte d allegemeine Gesundheitspflege, 2, 1886, 121; not Streptococcus acidi lactici Grotenfeldt, Fortschr dhed, 7, 1889, 124; Altrococcus lacticus Migula, Syst. d. Bakt., 2, 1900, 66; Chester, Man. Determ. Bact., 1901, 63) From fresh milk.

Streptococcus aerobius Heurlin. (Bakt. Untersuch. d. Keimgehaltes im Genitalkanale der fiebernden Wochnerinnen, Helsingfors, 1910, 60.) From the genital canal.

Streptococcus aerogenes Wirth. (Cent. f. Bakt., I Abt., Orig., 99, 1926, 290.) From human blood. An aerobic species which produced gas in deep glucose agar.

Streptococcus aerophilus Trevisan (I generie de specie delle Batteriacce, Milan, 1830, 31; not Streptococcus aerophilus Heurlin, Bakt. Untersuch d. Krimgehaltes im Genitalkanale der fiebernden Wöchnerinnen, Helsingfors, 1910, 62) From air.

Prepared by Miss Eleanore Heist, July, 1938, revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, February, 1911.

Streptococcus alactosus Smith and Brown. (Jour. Med. Res., 81, 1915, 455; Rockefeller Inst for Med. Res., Monograph 9, 1919; Streptococcus haemolyticus 111, Holman, Jour. Med. Res., 54, 1916, 377) From human tonsillitis; peritoneal pus. See Manual, 5th ed., 1939, 332 for description of this species.

Streptococcus albicans Migula. (Schminkeweisser Streptococcus, Tataroff, Inaug Diss., Dorpat, 1891, 69; Migula, Syst d. Bakt, 2, 1900, 22) From water.

Streptococcus albidus Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1804, 53.)
From Cantal cheese.

Streptococcus albus Sternberg. (Weisser Streptococcus, Muschek, Bakt. Untersuch. d Leitmeritzer Trinkwasser, Jahresber. d Oberrealschule zu Leitmeritz, 1887; Sternberg, Man. of Bact., 1893, 610, Micrococcus albus Macé, Traité pratique de Bact., 6th ed, 1912, 605) From water.

Streptococcus allantoicus Barker. (Jour. Bact., 40, 1943, 251.) From black mud. San Francisco Bay.

Streptococcus alvearis (Preuss) Trevisan. (Cryptococcus alvearis Preuss, 1868; Trevisan, I generi e le specie delle Batteriacee, 1859, 31.) From an infection (foulbroad?) in bees.

Streptococcus ambratus Trevisan (Micrococco ambrato, Perroneito and Ajroldi, Giornale d. r. Accad. d. Med. d. Torino, 48, 1885, 809; Trevisan, I generi e le specie delle Batteriacce, 1889, 30.) From the respiratory tract of a horse.

Streptococcus anhaemolyticus tulgarus Streptococcus anhaemolyticus tulgarus Zangemeister, Münch. med Wochnschr., 67, 1910, 1268; Rolly, Cent f. Bakt, I. Abt., Orig., 01, 1912, 90). Synonym of Streptococcus suprophylicus Mandelbaum (Ztschr. f., Hyg., 88, 1907, 37; see Brown, Monograph No. 9, Rockefeller Inst. Med. Res., 1919, 87). From vaginal secretions, milk and salva.

Streptococcus aphthicola Trevisan. (I generi e le specie delle Batteriacee, 1889, 30 ) From the lesions of foot and mouth

Streplococcus aromaticus van Beynum and Pette. (Directie Landbouw. Versing. Landbouwk. Onderzoek, 42, 1936, 360; also see Hoecker and Hammer, Iowa Agr. Exp Sta. Res Bull. 200, 1941, 317.) Produces ducetyl and small amounts of acetylmethylcarbinol in milk. From cream and butter.

Streptecoccus articulorum Flugge.
(Die Mikroorganismen, 2 Aufl, 1837, 1837, 1837) Associated with diphtheria Trevsan (I generi e le specie delle Batteriace, 1889, 30) considers this identical with Streptecoccus diphteriticus Cohn (Bettr. z Biol d. Pflanz., 1, Heft 2, 1872, 162).

Streptococcus asalignus Frost, Gumm and Thomas (Jour. Inf. Dis., 40, 1927, 703) From milk.

Streptococcus aurantiacus Killian and Fehér. (Ann. Inst Past., 55, 1935, 619.) From Sahara Desert soil.

Streptococcus bombyers Sartirana and Paccanano. (Cent. f. Bakt., T. Abt., Orig., 49, 1906, 331; probably not Streptococcus bombyers Zopf, Die Spaltpilze, 2 Auf., 1834, 52) From diesaed silk worms (Bombye mori). According to Paillot (Les maladies du ver A soe, Lyon, 1928, 171) this is the same as Streptococcus pastoranay Krassilstehik.

Streptococcus bonvicini Chester. (Streptococcus della leucaemia, Bonvicini, Cent f. Bakt, I Abt., 21, 1897, 211; Chester, Man. Determ. Bact., 1901, 59.) From a case of leucaemia in a doc.

Streptococcus borinus Trevisan. (Microccus borinus Trevisan, Rendionti Reale Inst. Lombardo di Sci. e Lett., Ser. II, 12, 1879; Trevisan, I generie le spece delle Batteriacee, 1889, 30; not Micrococcus bosinus Migula, Syst. d. Bakt., 2, 1990, 67, not Streptococcus bosinus Broadhurst, Jour. Inf. Dis., 17, 1915, 321; not Streptococcus borinus Froat and Engelbrecht, The Streptococcus (1910, 50.) From human throat; bovine, equine, feline and canine feces.

Streptococcus brens von Lingelsheim.

Streptococcus fermenti (Trevisan) Trevisan. (Micrococcus fermenti Trevisan, Batt Ital., 1879, 19; Micrococcus viscosus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 172; Trevisan, I generi e le specie delle Batteriacee, 1889, 31.) From a slimy growth in wines.

Streptococcus fischeli Chester. (Mieroorganismus No. 2, Fischel, Ztschr. f. Heilkunde, 12, 1801, 7 and Cent. f. Bakt., 9, 1891, 611; Chester, Man. Determ. Bact., 1901, 59.) From the blood of influenza patients

Streptococcus foctidus Migula. (Stinkcoccus, Klamann, Allegem, med, Centralzeitung, 1887, 1317; Diplococcus fluorescens foctidus Eisenberg, Bakt. Diag., 1801, 10, Migula, Syst. d. Bakt., 2, 1900. 38; Streptococcus fluorescens Chester, Man. Determ Bact., 1901, 70; Streptococcus fluorescens foetidus Miquel and Cambier, Traité de Bact., Paris, 1902, 792 ) From cases of ozena

Streptococcus galleriae Chorine. (Compt rend Soc. Biol., Paris, 95, 1926, 201) From the bee moth (Galleria mcllonclla)

Streptococcus genitalium Dimock and Edwards (Kentucky Agr Exp. Sta. Res Bull 286, 1928, 162.) Found com- . monly in the genital tract of mares.

Streptococcus giganteus Migula (Streptococcus giganteus urethrae Lustgarten and Mannaberg, Vierteliahrsschr. f Dermatologie u Syphilis, 1887, 918; Migula, Syst. d. Bakt , 2, 1900, 39.) From human urethra and from urine.

Streptococcus gingwae. (Quoted from Annals Pickett-Thomson Res Lab., 3. 1927, 154 ) From human gums and teeth. Streptococcus granulatus Henrici. (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1894, 55 ) From cream cheese.

Streptococcus haematosaprus Trevisan. (Mikrokokken der Fäulniss, Flugge, Die Mikroorganismen, 2 Aufl, 1886, 173; Trevisan, I generi e le specie delle Batterracee, 1889, 31.) From putrefying blood.

Streptococcus halitus Heim and Schlirf.

(Cent. f. Bakt., I Abt., Orig., 100, 1926, 39.) From deposit on the tongue.

Streptococcus havaniensis Sternberg (Man. of Bact., 1893, 612.) From acid vomit of a yellow-fever patient.

Streptococcus hemolyticus I. II and III Holman. (Jour. Med. Res., 54, 1916, 388.) From various human infections.

Strentococcus herbarum Schieblich. (Cent. f. Bakt., I Abt., Orig., 124, 1932, 269.) From green plant material. Motile. Related to Streptococcus lacis except it is flagellated. Kolbmuller (Cent. f. Bakt., I Abt., Orig., 155, 1935, 310) identifies this with Enterococcus.

Streptococcus hydrophoborum Trevisan (Streptococcus bei Rabies, Babes, Ztschr f. Hyg., 5, 1888, 184; Trevisan, I generi ele specie delle Batteriacce, 1889, 30 ) From the brain in a case of rabies.

Streptococcus influentiae Trevisan. (I generi e le specie delle Batteriacee, 1889, 30.) From equine influenza.

Streptococcus influenzae Thomson and Thomson. (Grippestreptokokkus, Seligmann, Cent. f. Bakt., I Abt , Ref., 50, 1911, 81; Thomson and Thomson, Monograph No. 16, Part I, Annals Pickett-Thomson Res. Lab., 1933.) Associated with influenza.

Holman. infrequens Streptococcus (Jour. Med. Res., 54, 1916, 388.) From various human infections.

Streptococcus kirchneri Chester. (Diplococcus, Kirchner, Ztschr. f. Hyg, 9, 1890, 528; Chester, Man. Determ. Bact, 1901, 57.) From sputum in cases of influenza.

Streptococcus kochii Trevisan. (I generi e le specie delle Batteriacee, 1889, 30) From rabbit septicemia

Streptococcus lacteus Schröter. (Kryptogam. Flora v. Schlesien, 3, 1, 1886,

149.) From the air and dust. Streptococcus lactis aromaticus Joshi

and Ram Ayyar. (Indian Jour. Vet. Sci. 6, 1936, 141.) Possibly Streptococcus cremoris Orla-Jensen. From cream.

Streptococcus lactis innocuus Stölting (Inaug. Diss., Kiel, 1935, 16.) From ripening cheese.

Streptococcus lagerheimii var. subterraneum Migula. (Hansgirg, Ocsterr. Zeitung, 1888, No. 7 and 8; Migula, Syst. d. Bakt., 2, 1900, 41.) From the wall of a wine cellar.

Streptococcus (Diplococcus) lanceolatus ou um Gaertner. (Cent. f Bakt, I Abt., Orig., 54, 1910, 546.) From mastitis in sheen

Streptococcus Iapillus Heim and Schlirf. (Cent. f. Bakt., I Abt., Orig., 100, 1926, 33) From the oral cavity

Streptococcus lentus Lehmann. (Lehmann, Deutsch. Arch. f. klin Med., 150, 1920, 144; Streptococcus proporacs lentus, 1644, 141; not Streptococcus lentus Brown, Rept. Proc. Third Internat. Congr. for Microbiol., New York, 1910, 173) From urine, cerviv., soutum and carrous teeth

Streptococcus libaviensis Flatzek (Cent. f. Bakt., I Abt., Orig., 82, 1919, 210; Bacterium libariense Flatzek, idem ) From human feces. Motile.

Streptococcus lucae Trevisan. (Micrococcus ulceris mollis de Luca, 1886, Trevisan, I generi e le specie delle Batteriacee, 1889, 30) From chancroidal ulcers

Streptococcus luteus Killian and Fehér (Ann. Inst. Past , 55, 1935, 619) From Saham Desert soil.

Streptococcus magnus Henrici. (Arb. bakt Inst. Karlsruhe, 1, Heft 1, 1894, 54) From Brie cheese

Streptococcus malaperti Trevisan (Mierococcus E, Malapert-Neuville, 1887, Trevisan, I generi e le specie delle flat teriacce, 1889, 30) From mineral water of hot springs at Schlangenhad.

Stephococcus malignus Trevisan (Strephococcus puppenes malignus Flugge, Die Mikroogenismen, 2 Aufl, 1886, 183, Trevisan, I generi e le specie delle Batteriacce, 1883, 30) From a diseased spleen. Prokably identical with Strephococcus pyogenes

Streptococcus mammitis boris Hutchens (Hutchers, in Besson, Prict. Ract Microbiol, and Serum Therapy. Trans. of 5th ed., 1913, 613.) From mastitis in cattle

Streptococcus margaritaceus Behriter.

(In Cohn, Kryptog. Flora v. Schlesien, 5, 1,1886,149.) From putrefying blood,

Streptococcus mathers: Muslow (Green producing streptococcus, Tunnicilif, Jour. Amer. Med. Assoc., 71, 1918, 1733; Mather's coccus, Jordan, Jour. Inf. Dis., 25, 1919, 30; Muslow, ibid., 31, 1922, 295.) From sputum in cases of influenza and pneumonia

Streptococcus maximus Weiss (Arb. bakt. Inst. Karlsruhe, & Heft 3, 1902, 180.) From a bean and carrot infusion.

Streptococcus melanogenes Schlegel. (Berl. tierarztl Wochnschr., 1906, No. 25, 464) Produces grayish-yellow pigment in gelatin. Associated with a disease of horses

Streptococcus meningitidis Bonome, (Cent f Bakt., 8, 1890, 172 and 703) From exudates from cases of cerebrospinal meningitis

Streptococcus merdarius Trevisan. (Streptococcus des selles, Cornil and Babes, Bactírica, 2nd ed., 1886, 118, Trevisan, I generi e le specie delle Butteriacce, 1889, 31.) From feces.

Streptococcus microapoilia Cooper, Keller and Johnson (Amer Jour. Dis of Children, 47, 1031, 388 and 506; these authors also use the trinomial Streptococcus micro-apolia enteritis ) From human throat and feces in enteritis in children See Manual, 5th ed., 1939, 331 for description of this species.

Streptococcus rurabilis Roscoc and Lunt (Phil Trans Roy Soc, London, 182, 1822, 648)

Streptococcus mixtus Bergey et al (Manual, 1st ed., 1923, 49) From a variety of pyogenic inflammations.

Streptococus morbilli Ferry and Fisher (Jour Amer Med Assoc, E), 1920, 933.) From blood of perrons in early stages of messles

Sitepiecoccus morbiliosus Trevisan, Ita-Micrococcus morbiliosus Trevisan, Itadiconti Ita-le Inst Lombardo di Sci. e Lett., Ser. II., 12, 1879; Trevisan, I generi e specie delle Buttermece, 1883, 31) From human, canine and poreme neades.

Streptococcus murisepticus v. Lingels-

blood in cases of subacute bacterial endocarditis.

Streptococcus saprogenes Trevisan. (I generi e le specie delle Batteriacee, 1889, 31.) From putrefying blood.

Streptococcus saprophyticus Mandelbaum. (Ztschr. f. Hyg., 58, 1008, 37.) See Streptococcus anhaemolyticus vulgaris From mucous membranes.

Streptococcus schmidti Trevisan. (Coccus bei Fadenziehende Mileh, Schmidt-Mulheim, Arch. f. d. ges. Physiol., 27, 1882, 490; Trevisan, I generi e le specie delle Batteriacce, 1889, 31.) From ropy milk.

Streptococcus seiferti DeToni and Trevisan. (Micrococcus bei Influenza, Scifert, in Volkmann, Sammlung Klin. Vortrage, 240, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1839, 1056.) From sputum and ansal secretions of influenza patients.

Streptococcus septicus Migula. (Streptococcus septicus Inquefans Babes, Bakt.
Unter. u. septische Prozesse des Kindesalters, Leipzig, 1889, 22; Streptococcus
septicus Inquefaciens Babes, according to
Eisenberg, Bakt. Diag, 3 Aufl., 1801, 312;
Migula, Syst. d. Bakt., 2, 1900, 27; not
Streptococcus septicus Flügge, Dio Mikroorganismen, 2 Aufl., 1886, 154.) From
the blood and organs of a diseased child.
Streptococcus septicus Flüggermicus Biondi.

(Ztschr. f. Hyg., 2, 1887, 194 and 225.) According to Migula (Syst. d. Bakt., 2, 1900, 6) this is a synonym of Streptococcus pyogenes. From human saliva.

Streptococcus sornthalii (Adametz) Migula. (Micrococcus sornthalii Adametz, Cent. f. Bakt., II Abt., 1, 1895, 465, Migula, Syst. d Bakt., 2, 1900, 20.) From milk and hard cheese.

Streptococcus sphagn: Migula. (Syst. d. Bakt., 2, 1900, 40.) From sphagnum in the Black Forest.

Streptococcus sputigenus Migula. (Syst. d. Bakt , 2, 1900, 24 ) From sputum.

Streptococcus stenos Bergey et al.

(Manual, 1st ed., 1923, 50.) From a variety of human inflammatory conditions

Streptococcus stramineus Henrici
(Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 50.) From Schlosskäse.

Streptococcus subacidus Holman. (Jour. Med. Res., 34, 1916, 388.) From various human infections.

Streptococcus suspectus Trevisan. (Streptococco dell' ematuria, Pisciangue' dei bovini; Trevisan, I generie le specie delle Batteriacce, 1889, 30) From blood and spleen in cases of bovine hematuria.

Streptococcus tenuis Veillon (Arch Méd. Exp. et Anat., 6, 1894, 161.) From human mouth.

Streptococcus terricola van Steenberge. (van Steenberge, Ann. Inst. Past., 34, 1920, 806; not Streptococcus terricola Killian and Fehér, Ann. Inst. Past., 65, 1935, 619.) From garden soil.

Streptococcus toxicatus (Burrill) De-Toni and Trevisan, (Micrococcus loxiatus Burrill, The Bacteria, Illinois Industrial Univ., 11th Ann. Rept., 1829, 2; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1065) From diseased plant tissue.

Streptococcus trifoliatus Miguli.
(Diplococcus ureae (non pyogenes) Infoliatus Rovsing, Die Blasenentsüdatus en, ihre Actiologie, Pathogeness und Behanglung, 1890, 43; Migula, Syst. d Bakt., 2, 1900, 29.) From cases of evatitis.

Streptococcus turbidus Lehmann and Neumann. (Bouillon trubende Streftkokken, Behring, Cent. f. Bakt. 12,1876. 103; Lehmann and Neumann, Bakt. Diag., I Aufl., 2, 1896, 125.) From varous human infections, especially cryspelss Presumably a smooth culture of Streptoccus pyogenes.

Streptococcus tyrogenus Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 50)
From cheeses.

Streptococcus ureae Migula. (Streptococcus pyogenes ureae Roysing, Die Blas-

enentzündungen, ihre Aetiologie, Pathogenese und Behandlung, 1890, 45; Myuda, Syst. d. Bakt., 2, 1900, 28, not Streptococcus uree Trevisan, Igenerie le specie delle Batteriacee, 1889, 31.) From cases of twattie.

Streptococcus urinae Migula. (Diplococcus ureae (non pyogenes) Rovsing, loc cit., 45; Migula, Syst. d. Bakt, 2, 1900, 13.) From cases of evalutis.

Streptococcus raccinae (Cohn) Zopf. (Microsphären der Vaccine, Cohn, Arch f path. Anat., 55, 1872, 237, Uterosphärera taccinae Cohn quoted from Cohn, Betträge z. Biol, d Plannen, 1, Heft, 2, 1872, 161; Micrococus raccinae Cohn, idem; Zopf, Die Spaltpilze, 3 Auf., 1885, 52) From lymph of cow pox pastules.

Streptococcus varicellae Trevisan (Microbio della varicella, Bareggi, 1833, probibly in Gazz. Med. ital Lomb Milano, 223-242; Trevisan, I generi e le specie delle Batteriacee, 1833, 30 ) From chicken.rov. pustules

Streptococcus rarolae Trevisan. (Microsphaeren der Varnola, Cohn, Arch f path Anat, 55, 1872, 237, Micrococcus vandae Cohn, 1872, quoted from Trevisan, Ignene le specie delle Batternacee, 1881, 30) From lymph of small pox pustules. Regarded by Cohn (Beiträge z Bud d Pflamen, I, Heft 2, 1872, 161) as a variety of Micrococcus raccinae Cohn

Streptococcus rariolae-orinae (Plaut) DeToni and Trevien. (Micrococcus rariolae orinae Plaut, Das organisate Contagium der Schafpocken und die Mitigation desselben, Leipzug, 1822, DeToni and Trevisun, in Siccardo, Sylloge Fungruum, 8, 1839, 1033 ) From the lymph in abeep pox pustules

Streptococcus termiformis Sternberg (Wurnformiger Streptococcus, Maschek, Bakt, Unters. d. Leitmentzer Trinkwasser, Jahreab, d. Oberrealschule zu

Leitmeritz, 1837; Sternberg, Man. of Bact., 1833, 611.) From water.

Streptococcus tersatilis Broadhurst. (Jour Inf. Dis., 17, 1915, 323) From throat of dogs, horse and cattle feees, etc.

Streptococcus rini Migula. (Vicrococcus suprogenes rini II, Kramer, Landwirtsch Versuchsstat, 57, 1830, 225 and Die Bakt. in ihren Beziehungen z Landwirtsch u. d. Landwirtsch -technisch. Gemerben, 8, 1892, 140; Migula, Syst. d. Bakt. 2, 1900, 33 1 From wine.

Streptococus siecosus Lehmann and Neumann (Schleimiger Streptokokken, Behring, Cent. I. Bakt., 12, 1832, 193; Lehmann and Neumann, Bakt. Drig., 1, Aufl. 2, 1896, 125.) Pron various human infections. Presumably a mucoid culture of Streptococcus progents

Streplococcus estulorum Trevisan. (Micrococco della diarres bianca dei vitellini, Perroncito, 1885, Trevisan, I generie le specie delle Batteriacce, 1889, 30.) From white diarrhoea of calves.

Streptococcus rulgaris Locning (Münch. med Wochnschr, 67, 1910, 173 and 217, Streptococcus pyogenes rulgaris Thomson and Thomson, Ann Pickett-Thomson Res Lab, 5, 1927, 182.) Names applied to Streptococcus pyogenes.

Streptococcus weissii Trevican (Atti d Accad Fisio Medico-Statistica in Milano, Ser. IV, 5, 1885, 119) From lung exudate in pleuromeumons of cattle.

Streptococcus syths Trevisan (Torulacte de la bière maisde, Pasteur, Trevisan, I geners e le specie delle Batteriacee, 1830, 31.) From spoiled beer.

Streptotaphylococcus parvulus Heurlin, (Heurlin, Bakt Unters d Keingchaltes im Genitalkanale der fiebernden Woehnerannen. Helsungsfors, 1910, 138) From genital ennal Intermediate between Streptococcus anaerobius Krinig and Staphylococcus parrulus Veillon and Zuber.

# Genus III. Leuconostoc Van Tieghem emend. Hucker and Pederson.

(Van Tieghem, Ann. Sci. Nat., 6, Sér. 7, 1878, 170; Betacoccus Orla-Jensen, The Lactte Acid Bacteria. Mem. Acad. Sci. Danemark, Sec. d. Sci., 5, Sér. 8, 1919, 146; Hucker and Pederson, New York Agr. Eyp. Sta. Tech. Bul. 167, 1930, 66.) From Latin leucus, clear, colorless; M. L. Nostoc, a genus of blue-green algae.

Cells normally spherical Under certain conditions, such as in acid fruits and vegetables, the cells may lengthen and become pointed or even elongated into a rod. Certain types grow with a characteristic alime formation in sucrose media. Grow on ordinary culture media, but growth is enhanced by the addition of yeast, tomato or other vegetable extracts. Generally, a limited amount of acid is produced, consisting of lactic and acetic acid; alcohol is also formed, and about one-fourth of the fermented glucose is changed to CO<sub>2</sub>. Levo lactic acid is always produced, and sometimes dextro lactic acid also. Milk is rarely curdled. Fructose is reduced to mannitel. Habutat: Milk, plant iuries.

The type species is Leuconostoc mesenteroides (Cienkowski) Van Tieghem.

## Key to the species of genus Leuconostoc.

- I. Acid from sucrose.
  - A. Acid from pentoses,
    - 1. Leuconostoc mesenteroides.
  - B. No acid from pentoses.
- 2. Leuconostoc dextranicum.
- II. No acid from sucrose.
  - 3. Leuconostoc citrovorum.
- 1. Leuconostoc mesenteroldes (Cienkowski) Van Tieghem. (Ascococcus mesenteroides Cienkowski, Arb. d. Naturf Gesellsch. a. d. Univ. a Charkoff, 1878, Van Tieghem, Ann. Sei. Nat., 6, Sér. 7, 1878, 170, Leuconostoc indicum Liesenberg and Zopf, Beitr. z. Physiol Morph niederer Organis., Heft 1, 1892, 19, Streptococcus mesenterioides Migula, Syst d. Bakt., 2, 1900, 25, Leuconostoc agglutinans Barendrecht, Cent f. Bakt., II Abt , 7, 1901, 627; Leuconostoc aller Zettnow, Ztschr. f. Hyg., 57, 1907, 154, Leuconostoc opalanitza Zettnow, loc. cit; Betacoccus arabinosaceus Jensen, The Lactic Acid Bacteria, 1919, 152: Leuconostoc arabinosaceus 223; land. Jour. Baet., 5, 1920, Bacillus pleofruct: Savage and Hunwicke,

Spec. Rept. Food Investigation Board, London, 1923, 134; Leuconostoe pleofrudi Pederson, N. Y. Agr. Evp. Sta. Tech Bull. 150 and 151, 1929.) From Greek mesenterium, mesentery; eidus, form (like).

Probable synonym: Leuconostoc soyat Belenky, Bull. Sci., Res. Inst. for Leguminous Crops, Moscow (Russian), 5, 1934, 132.

Spheres: 0.9 to 1.2 microns in dameter, occurring in pairs and short or long chains. In sucrose solutions the chains are surrounded by a thick, gelatinous, colorless membrane consisting of dextran Gram-positive.

Glucose gelatin colonies Small, white to grayish-white, raised, nodular.

Revised by Prof. G. J. Hucker and Prof. Carl S. Pederson, New York State Experiment Station, Geneva, New York, September, 1938, further revision, December, 1943.

Glucose gelatin stab: Growth along entire stab. No liquefaction.

Sucrose broth: Abundant growth with massive formation of shmy material. Potato: No visible growth.

Indole not formed

Acid from glucose, fructose, galactose, mannose, xylose, arabinose, sucrose, and generally from lactose, raffinose, salicin and mannitol. Rarely acid from dextrin, starch, inulin, sorbitol, rhamnose or

glycerol. Nitrites not produced from nitrates.

Produces slime from sucrose la pronounced in sucrose celatin stab.

Aerobie, facultative

Optimum temperature 21° to 25°C.

Distinctive characters. Active slime

producer in sucrose solutions. Source · Slime in sugar factory

Habitat: Most active of the genus Encountered in fermenting vegetable and other plant materials Frequently isolated from slimy sugar solutions

2 Leuconostoc dextranteum (Beijerinck) Hucker and Pederson. (Loctococus dextranticus Beijerinck, Folia Microbiologica, Delft, 1912, 377; Betacocus borse Orla-Jensen, The Lactic Acid Bacteria, Copenhugen, 1919, 152 (Leuconotoc borse Nolland, Jour. Bact. 6, 1920, 223); Strephococcus paractirozorus Hammer, Research Bul 63, Jowa Agr. Exp Sta., 1920; Hucker and Pederson, N. Y. Agr. Exp. Sta. Tech. Bull. 187, 1930, 67.) From Latin dezter, right; M. L. deztranum, devtran, M. L. deztranuca, tested to dextran, M. L. deztranuca, tested to dextran.

Norn- The description of Streptooccus b, v. Freudenreich (Cent. f. Bakt., II Abt. s, 1877, 47) renamed Streptococcus kefir by Migula (Syst d Bakt., z, 1900, 44) is too indefinite to permit the determination of its exact relationship to the organisms in this genus It is clear, however, that the Streptococcus kefir of these authors and that of Evans (Jour Agr. Res., 18, 1918, 235) were very similar to if not identical with Leuconostic destructions. Streptococcus disnostic destructions. tendens Hammer (Iowa State Coll. Jour. Sci , 2, 1927, 5) may also be identical with Leuconostoc destrancem.

Spheres 0 6 to 1 0 micron in diameter, occurring in pairs and in short chains.

Gelatin stab. Gray filiform growth in

Agar colonies: Small, gray, circular, slightly raised, entire.

Glucose broth: Slight grayish sedi-

Litmus milk: Acid, coagulation. Frequently shows slight reduction of litmus in bottom of tube.

Potato · No visible growth.

Indole not formed.

Nitrites not produced from nitrates

Produce slime from sucrose in rapidly

Acid from glucose, fructose, galactose, maltose, sucrose, and generally from lactose and mannose. No acid from xylose, arabinose, glycerol, rhamnose, sorbitol, mannitol, starch, rarely raffinose, inulin or dextrin

Aerobic, facultative.

Optimum temperature of growth 21° to 25°C.

Distinctive characters: Produces moderate amount of slime in sucrose solutions.

Source · Dairy starters.

Habitat: Found both in plant materials and in milk products.

3. Leuconostoc citrovorum (Hammer) Hucker and Pederson. (Streptococcus citrovorus Hammer, Research Bull. No. 63, Iowa Agr. Evper. Sta., 1920, Hucker and Pederson, N. Y Agr. Exp Sta. Tech. Bull. 167, 1930, 67 ) From Latin citrus, the citron tree, M. L., Jenon or orange, hence citric acid, sovo, devour.

Spheres: 0.6 to 10 micron in diameter, occuring in pairs and chains. Grampositive.

Gelatin stab: Filiform growth in stab. No liquefaction.

Agar colonies: Small, gray, entire, slightly raised.

Agar slant: Small, gray, discrete colonics.

Glucose broth: Slight gray sediment. Litmus milk: Slightly acid with partial reduction of litmus.

Potato, No visible growth Indole not formed.

Nitrites not produced from nitrates.

Grows poorly on ordinary media without the addition of yeast extract or other growth accessory substance.

Acid from glucose, fructose, galactose and lactose. Generally does not form acid from mannose, sucrose, maltose, xvlose, arabinose, rhamnose, raffinose, glycerol, dextrin, inulin, starch, salicin, mannitol or sorbitol.

Uses citric acid in milk.

Aerobic, facultative.

Optimum temperature 20° to 25°C.

Distinctive character: Non-slime producer.

Source. Dairy products

Habitat Found in milk and dairy products.

Appendix: This includes species that probably belong in this genus. The descriptions are too meager to permit drawing any definite conclusion regarding their relationship to the three species recognized above

Bacterium laevolacticum Migula. (Bacillus acidi laevolactici Schardinger, Monatsh. f. Chemie, 11, 1890, 544; Migula, Syst d. Bakt., 2, 1900, 406; Bacterium acidi laevolactici Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 178.) From well water.

Leuconostoc lagerheimii (Ludwig, Lehrb. d. niederen Kryptog. 1892. 29: Streptococcus lagerheimu Migula, Syst. d. Bakt., 2, 1900, 41.) From slimy sugar solutions.

Micrococcus gelatinogenus Brautigam. (Pharmaceutische Centralballe, 1891, No 30.) From the air. Forms gum in 60crose media.

Micrococcus gummosus Happ. (Inaug. Diss., Basel, published in Berlin, 1893, 31.) From slimy sugar solutions.

Connermana Murocorcus betae (Oesterr .- Ungar. Ztschr. f. Zuckerind u Landw., 156, 1907, 883.) From sugar beet juice.

Streptococcus citrovorus-paracitrovorus Csiszar. (Milchwirtsch and Fortsch., 18, 1936, 68.) From cream and butter.

Streptococcus hornensis Boekhout. (Cent. f. Bakt., II Abt., 6, 1900, 162) From slimy, sweetened condensed milk. A strong dextran former. Related to Leuconostoc mesenteroides.

Zoogloeg termo Cohn. (Cohn, Nov. Act. Acad. Caes. Leop.-Carol. Nat. Cur., 24, 1854, 123.) The only species in the genus Zoogloca as originally proposed. From running water. Scheibler used this name for a zoogloea-forming organism from slimy sugar solutions in Neue Ztschr, I Rubenzucker- Ind., 1, 1878, 366 and probbably also in Ztschr. d. Vereins f. Rüben zucker- Ind , 1874, 330. The latter reference apparently is not available in America. See Buchanan, General Syst Bact, 1925, 530 for a history of the genus Zoogloea

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# Key to the species of genus Lactobacillus.

- I. Produce only traces of by-products other than lactic acid. Homofermentative. A. Ontimum temperature 37° to 60°C or higher. Sub-genus Thermobacterium Orla-Jensen (The Lactic Acid Bacteria, 1919, 160).
  - 1 Acid from lactose
    - a. Optimum temperature 37° to 45°C.
      - b. Produce leve lactic acid
        - 1. Lactobacillus caucasieus.
        - 2. Lactobacillus lactis.
      - bb. Produce inactive or dextro lactic acid.
        - c. Microaerophilic.
        - 3. Lactobacillus helreticus. 4. Lactobacillus acidophilus.
      - cc. Anaerobic in freshly isolated cultures.
    - 5. Lactobacillus bifidus.
    - aa. Optimum temperature 45° to 62°C; usually no acid from maltose.
      - 6. Lactobacillus bulgaricus. 7. Lactobacillus thermophilus.
  - 2. No acid from lactore.
- 8. Lactobacillus delbrueckii.
- B. Optimum temperature 28° to 32°C. Sub-genus Streptobacterium Orla-Jensen (loc. cit., 166).
  - 1. Acid from lactose
    - a Produces dextro lactic acid. Often prefers lactose to sucrose and maltase
    - 9. Lactobacillus casei. aa. Produces inactive lactic acid.
  - 2 No acid from lactose.
- 10. Lactobacillus plantarum.
- 11. Lactobacillus leichmannii. II Produce considerable amounts of by-products other than lactic acid (carbon diovide, alcohol and acetic acid; mannitol from fructose). Heterofermentative. Sub-genus Betabacterium Orla-Jensen (loc. cit., 175).\*
  - A. Optimum temperature 28° to 32°C. Usually ferment arabinose.
  - 1. Does not ferment raffinose, and usually does not ferment sucrose or lactore. 12. Lactobacillus brevis.
    - 2. Ferment raffinose, sucrose and lactose.
      - 13. Lactobacillus buchneri.
      - 14. Lactobacillus pastorianus.
  - B. Optimum temperature 35° to 40°C or higher. Usually does not ferment arabinose
    - 15. Lactobacillus fermenti.

<sup>\*</sup> Also see discussion of Betabacterium caucasicum, p. 358.

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Minimum 18° to 22°C. Maximum 50°C. Source From milk and cheese.

Habitat: Undoubtedly widely distributed in milk or milk products.

3. Lactobacillus helveticus (Orla-Jensen) Holland. (Bacillus e, von Freudenreich, Cent f. Bakt, H Abt., I, 1895, 173; also Landw Jahrb. d. Schweiz, 1895, 211, Bacillus case: e, v. Freudenreich and Thöni, Landw. Jahrb. d. Schweiz, 1904, 526, also Orla-Jensen, Cent. f. Bakt., II Abt., 13, 1904, 609; Cascobacterium e, Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 337; Thermobacterium helteticum Orla-Jensen, Maelkeri-Bakteriologie, 1916, 33, also the Lactic Acid Bacteria, 1919, 164; Bacterium case: e, Holland, Jour. Bact., 6, 1920, 221, Holland, ibdd., 201. Bact., 5, 1920, 221, Holland, ibdd., 223) From Latin heltetievs, Sniss.

Rods 07 to 09 by 20 to 60 microns, occurring singly and in chains. Nonmotile. Gram-positive

Whey gelatin colonies Does not grow readily at temperatures required for incubation of gelatin

Lactose agar colonies Small, grayish, viscid

Milk Acid, with coagulation, may become slimy.

Nitrites not produced from mitrates

Acid from glucose, fructose, galactose, mannose, maltose, lactose, and smaller amounts from dextrin The lactic acid is mactive.

Temperature relations Optimum 40° to 42°C. Minimum 20° to 22°C Maximum 50°C.

Microaerophilie

Source: From sour milk and cheese Habitat Widely distributed in dairy products.

4 Lactobacillus acidophilus (Moro) Holland (Bacillus acidophilus Moro, Wiener kin Wochnschr, 13, 1900, 114; also Jahrb. f Kinderheilkunde, 52, 1900, 38; Holland, Jour Bact. 5, 1920, 215, Plocamobacterium acidophilum Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 510; Thermobacterium intestinale

Orla-Jensen, Orla-Jensen and Winther, Cent. f. Bakt., II Abt., 98, 1936, 321.) From Latin acidus, sour; M. L. acidus, acid and Greek philus, loving.

Possible synonyms: Milchsäurebacillus, Boas and Oppler, Deutsche med Wochnschr., 21, 1895, 73; Diagnostik und Therapie d. Magenkrankheiten, II Teil, 1907, 265 (Lactobacellus boas-opplers Bergey et al., Manual, 1st ed., 1923, 243); Bacillus exilis Tissier, La flore intestinale des nourrissons, Paris, 1900, 102; Bacillus gastrophilus Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 424 (Bacterium gastrophilum Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 305); Bacillus acetogenus a Distaso, Cent I. Bakt., I Abt., Orig., 59, 1911, 49; Bacillus acctogenus & Distaso, 1bid., 51; Bacillus acetogenus proteiformis Distaso, ibid., 5% Bacıllus acetogenus exilis Distaso, ibid, 53; Bacillus paraexilis Distaso, ibid , 56; Bacillus dimorphus Distaso, ibid, 55, Bacillus dimorphus var. longa Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1912, 440; (Bacteroides dimorphus Bergey et al, Manual, 1st ed., 1923, 258); Streptobacillus longus Distaso, ibid., 439; Thermobacterium acidophilum Henneberg, Cent. f. Bakt., II Abt , 91, 1934, 102.

Description of More supplemented by material from Kulp and Rettger, Jour. Bact., 9, 1924, 357; Curran, Rogers and Whittier, Jour. Bact., 25, 1933, 265; and Rettger, Levy, Weinstein and Wess, Lactobacillus acidophilus, Yale Univ. Press. New Haven. 1935.

Rods. 06 to 09 by 15 to 60 microns, occurring singly, in pairs and in short chains with rounded ends. Non-mothe Dimensions variable (Kulp and Retter). (Curran, Rogers and Whittier). Grampositive; old cultures often Gram-negative (Moro).

Gelatin: No growth at 20°C No lique-

Wort-agar (Moro) or tomato agar (Kulp and Rettger) plates: Surface colonies, peripheries a capilliform mare of lors, delicate, twisted, fuzzy projections, certer appears as a thick, dark, felt-life mass. Deep colonies, small, irregularly 'shared, with fine radiate or ramified projections

Wort-agar slants Growth scanty, limited, dry, yell-like.

Wort-broth After 48 hours, fine, flocculent sediment. Other and broths sedi-

ment whitish, slight turbidity
Milk: Slow growth with small inoculum. Coagulates from the bottom up

Potato · No growth

Acid but no gas from glucose, sucrose and lactose (Moro) Acid from glucose, fructose, galactose, manose, maltose, lactose and sucrose Some cultures ferment raffinose and trehalose and have slight action on dextrin Xylose, arabinose, rhamnose, glycerol, mannitol sorbitol, dulcitol and inositol not fer mented (Kulp and Rettger) Inactive lactic acid and volatile acids formed from Sucras (Cyuro, Bocers, and Whitter).

No visible growth in carbohydrate-free media (Rettger, Levy, Weinstein and Weiss)

Optimum temperature 37°C No growth at 20° to 22°C (Moro) Maximum temperature 43° to 48°C (Curran, Rogers and Whittier).

Not pathogenic for laboratory animals Microaerophilic

Distinctive characters Grows in acid media Unless frequent transfers are made, organism may become Gram-negative and mpidly develop characteristic degeneration forms (Moro) The so-called original strains of Becillus acidophilus from the Kráf collection, described and cilled Microbacterism of Distriction by Orla-Jensen, do not have the characteristics given by Moro

Source: From the feces of milk-fed infants. Also from the feces of older persons on high milk or betose or dextrincontaining diets.

Habitat As for source

5 Lactobacillus bifidus (Tissier) Holland. (Bacillus bifidus communis and Bacillus bifidus Tissier, Recherches aur In flore intestinal des nourrissons, Paris, 1900, 85; Bacteroides bifdus Castellani and Chalmers, Man. Trop. Med, 3rd ed, 1919, 960, Holland, Jour Bact, 5, 1920, 223, Nocardus bifda Vuillenin, Encyclopédic Mycolog, Paris, 2, Champignons Parsistes, 1931, 132; Actinomyces bifdus Naminizi, in Pollacci, Trat. Micopat. Umana, 4, 1934, 13; Cohnstreptothriz bifdus Negroni and Fisher, Rev. Soc Argentina Biol., 26, 1944, 315.) From Latin bifdus epili in two, Left.

Possible synonyms: Coccobacillus oriforms Tissier, Ann. Inst. Past., 22, 1908, 189 (Bacterum eviforme Le Blaye and Guggenheim, Manual pratique de diagnostique Bactériologie, Paris, 1914; Bacteroides oviforms Levine and Soppeland, Iona Engineering Try Sta Bul. 77, 1926, 35), Bacillus tentriosus Tissier, Ioc et. (Bacteroides tentriosus Eggerth, Jour. Bact., 30, 1935, 281), Diplobacillus acuminatus Distaso, Ioc. et. (Bacteroides acuminatus Bergey et al., Manual, 1st ed., 1922, 200)

Description supplemented from Weiss and Rettger, Jour Bact , 28, 1934, 501.

Small, stender rods: Average length 40 microns, 0.5 to 0.7 by 2 to 8 microns (Weivs and Rettger), occurring singly or in pairs and short claims, parallel to each other, very variable in appearance. Branched and club forms develop in some cultures. Non-motile Gram-positive but stams irregularly in old cultures (Tesser).

Little or no growth in carbohydrate-free

Deep sugar-agar colonies: After 3 days, solid with slightly irregular edge, whitish. Grow up to 3 cm from the surface forming a ring. Average diameter 3 mm. No gas.

Sugar broth Good growth Turbid within 3 days Clears with flocculent precipitate.

Milk Good growth with large inoculum No congulation (Tissier). May or may not congulate milk (Weiss and Rettger)

Acid but no gas from glucose (Tissier). Acid from glucose, fructose, galactose, sucrose, inulin and usually from destrin, starch, maltose, raffinose and trehalose. A few strains form acid from lactose and sahcin. The acid co issists of inactive lactic acid and 18 to 25 per cent of volatile acid (Weiss and Rettger).

Optimum temperature 37°C. May show slight growth at 20°C Killed at 60°C in 15 minutes

Non-pathogenic for mice or guinea pigs. Strict anaerobe (Ti-sier). Strict anaerobe in primary culture becoming microaerophilic (Weiss and Rettier).

Distinctive characters: Bifurcations and club-shaped forms (Tissier), particularly in infant feces and in primary culture (Weiss and Rettger).

Source From feces of nursing infants. Habitat Very common in the feces of infants. May constitute almost the entire intestinal flora of breast-fed infants. Also present in smaller numbers with bottle fed infants. Possibly more widely distributed than indicated in the intestines of warm blooded animals.

5a Lactobacillus parabifdus Weiss and Rettger (Incierium bifdum Orla-Jessen, The Lactic Acid Bacteria, 1919, 192. Bactero des bifdus (Group 2) Eggerth, Jour Bact, 30, 1935, 295, Lactobacillus bifdus 11 or Lactobacill is parabifdus Weiss and Bettger, Jour. Bact., 55, 1938, 17-Jour Inf. Dis. 62, 1938, 115, 1

This is the mo e anaerubic variety of the bifid organisms from feces and seems to be more commo: in the intestine of adults. In contrast to Lactobacillus bifidus, it produces more volatile acid well as dextro lactic acid, and ferments arabinose, xylose and melezitose but not mannose.

6 Lactobacillus bulgaricus (Lucrssen and Kuhn) Holland. (Bacillus A, Grigoroff, Revue Méd. Susse romande, 25, 1905; Bacillus bulgaricus Lucrssen and Kuhn, Cent. f. Bakt., 11 Abt. 20, 1907, 241; Thermobacteri im bulgaricum Orla-Jensen, The Lactic Acid Bacteria, 1919, 184; Holland, Jour. Bact., 5, 1920, 215; Acidobacterium bulgaricum Schlirt, Cent. f. Bakt., I Abt., Orig., 97, 1925, 116; Plocamobacterium bulgaricum Lehmann and Neumann, Bakt. Diag., 7 Auft., 2, 1927, 511.) From Latin bulgaricus, of or related to Bulgaria.

Probable synonyms: Lactobacillus longus Beijerinek, Arch. néerl. d. sci. exact. et nat., Sér. 2, 7, 1901, 212 (not Lactobacillus longus Bergey et sl. Manual, 4th ed., 1931, 312); Bacterium casci filans Gorini, Rend. R. Acc. Lincei, 21, 1912, 472; Cent. f. Bakt., II Abt., 37, 1913, 1.

Description of Lucrssen and Kühs supplemented by Grigoroff, loc. cit; Cohendy, Compt. read. Soc. Biol. Poris, 58, 1906, 361; Kuntze, Cent. f. Bakt, Jl Abt., 21, 1908, 737; Bertrand and Duchacek, Ann. Inst. Pst., 23, 1909, 402; White and Avery, Cent. f. Bakt., Il Abt, 25, 1910, 161; Itahe, Jour. Bact., 5, 1918, 420; Orla-Jensen, The Lactic Acid Beteria, 1919, 164; Kulp and Rettger, Jour Bact., 9, 1921, 357; Sherman and Hodge, Jour. Dairy Sci., 19, 1936, 491.

Rods: Slender rods with rounded ends, often in chains. Non-motile. Grampositive, older cultures showing unstained portions (Lucressen and Kuha).

Whey gelatin: No liquefaction (White and Avery).

Colonies: Flat, yellowish-white, 2 to 3 mm. Old cultures have dark centers Deep colonies globular (Luerssen and Kühn).

Whey agar colonies: Circular to irregular (White and Avery)

lar (White and Avery)
Milk. Coagulation at 37°C. No gas.

No decomposition of casein.

Potato · Yellow-white colonies (Luerssen and Kuhn). No growth (Grigoroff),
(Cohendy), (White and Avery).

Indole not formed (Grigoroff), (White and Avery),

Nitrites not produced from nitrates. Results on acid production from sugary. Glucose, lactoses and galactose ar apparently always fermented while xylose, arabinose, sorbose, rhammose, dolin, mannitol, devtrin, indin and starch

are never fermented. Littly notifiers (Gigoroff) (Cohendy) noted fermentation of fruction, maltine and surrise Later workers (Hertrand and Ducharck, (Orla-Jensen), (Rahe), /kulp and Rettgre), (Sherman and Hodge noted van able or negative results on sucross and togs and unbested fructions.

Forms high needity in milk 4 he lastic need is inactive (fingend). But trand and Duckneck), White and two or levo (White and Avers). Only Jersen with small quantities of volatile and (White and Avers).

Aerobic or anaerobic Lucresen and Kühn) Microaerophilic (White and Avery). Anaerobic in fresh indistin-(Sherma and Hofee)

Optimum temperature 45 to 304 Minimum 22°C (Luerseen and Kuhn

Distinctive characters. This species at present is regarded as including the high temperature organisms isolated from milk with difficulty. These fer ment glueses, galactose and lattices but usually do not ferment success malloce of unheated fructose when freshly isolated.

Source: Originally isolated from you hurt.

Habitat Probably present in many milk products if held at high temperature.

 Lactobacillus thermophilus tyers and Johnson (Jour Bact, 9, 1924, 201)
 From Greek thermos, heat and philus, loving

Description of Ayers and Johnson supplemented by material from Charlton, Jour. Dairy Sci., 15, 1932, 393

Rods: 0.5 by 3.0 microns Stains irregularly. Non-motile (Charlton) Gram-positive

Gelatin stab No liquefaction

Agar plate Small colonies Agar slant · Slight, translucent growth (Charlton)

Broth. Turbid (Charlton) Litmus milk: Acid Natrites not produced from natrates (Charlian)

Vend from glucose, bettee, surves, starch and trace from Elycted. No acid firm saliem, mainted, riffure or mulin. (Ayers and Johnson). Acid from fructore, galactore, rannes e, maintere, riffures and destrin. No acid from artidoxes, splees, glyceol, rhamsee, saliem, mulino mannitel. Dextro lactus and formed. (Challon).

This is the thermoplatic hetolocidus obtained from posteurired milk which causes our point colonies on agar plates

Temperature relations Optimum tem perature 50° to 62.5°C Minimum 30°C Maximum G°C Thermal death point 71°C for 30 minutes or 82°C for 23

Facultative amende Grows best aerobically

Source From resteurized milk.

Habitat Known only from pasteurited milk

s Lactobacillus delbrueckii (Leichmann i Benerinck (Bacillus delbrückis Leichmann, Cent f Pakt, II Abt . 2. 186. 281. Bacillus acidificans longissimus Lafar, Cent f Bakt, II Abt, 2, 1896, 195, Eacillus (?) acidifeans Micula. Syst. d. Bakt. 2, 1900, 801, Benerinck, Arch need d sei exactes et nat... Hadrlem, Ser. 2, 7, 1901, 212; Thermo-Lacterium cereale Orla Jensen. The Lactic Acid Bucteria, 1919, 161. Bacillus geidificans longissimus Holland, Jour Bact , 5. 1920, 216, Loctobacillus acidificanstongustimus Holland, thel . 216. Lactobecillus cereale Holland, abid , 223; Lactobactersum delbrucks (sic) van Steenberge, Ann Inst Past, \$4, 1920, 820 ) Named for Prof. M Delbrück, German bacteriologist

Description of Leichmann supplemented by material from Henneberg, Cent f Bakt . II Abt . 11, 1903, 154

Rods 0.5 to 0.8 by 2 0 to 9 0 microns (Henneberg), occurring singly and in short chains Non-mottle. Gram-positive. Gelatin colonies: Small, gray, circular, not liquefied.

Agar colonies: Small, flat, crenated.

Agar slant · Narrow, translucent, soft,
grayish streak

Broth · Shightly turbid.

Milk: Unchanged.

Nitrites not produced from nitrates. Acid from maltose and sucrose (Leichmann) and glucose, fructose, galactose and dextrin. No acid from xylose, arabinose, rhamnose, lactose, raffinose, trehalose, inulin, starch, mannitol or α-methyl-glucoside (Henneberg). Levo rotatory lactic acid is formed. Forms 16 per cent acid in many lactic acid in formed.

This is the high temperature organism of fermenting mashes. In fresh isolations it apparently has a higher optimum temperature than when held in pure culture.

Optimum temperature 45°C.

Microaerophilic

Source From sour potato mash in a distillery

Habitat Fermenting vegetable and grain mashes

9 Lactobacillus casel (Orla-Jensen)
Holland (Bacillus α, ν Freudencich,
Ann d Microg, 2, 1890, 266, also Landw.
Jahrb d Schweiz, 1891, 20; Bacillus
case: α, von Freudenreich and Thöi,
Landw Jahrb d Schweiz, 1904, 526, also
Orla-Jensen, Cent f Bakt, 11 Abt, 18,
1904, 669, Cascobacterium rulgare OrlaJensen, Maelkeri-Bakteriologie, 1916, 35;
Streptobacterium case: Orla-Jensen, The
Lactic Aerd Bacteria, 1919, 166; Bacterium case: α, Holland, Jour Bact., 5,
1920, 221, Holland, told ) From Latin
caseus, cheese.

Rods Short or long chains of short or long rods Non-motile. Gram-positive. Milk. Acid with coagulation in 3 to 5 days or longer, may become slimy Forms about 1 5 per cent lactic acid

Utilizes casein and therefore important in cheese ripening.

Acid from glucose, fructose, mannose, galactose, maltose, luctose, mannitol and

salicin. May or may not ferment sucrose. Mostly devtro lactic acid formed though a small amount of levo lactic acid may be formed. Only lactic acid produced with a trace of other by-products

This is the more common lactic said rod found in milk and mulk products. Orla-Jensen distinguishes it from Laciobacillus plantarum in that it produces dextro lactic acid and usually ferments lactose more readily than sucrose or maltose.

Temperature relations: Optimum 30°C. Minimum 10°C. Maximum 37° to 40°C and with some strains 45°C

Microaerophilic.

Source: From milk and cheese.

Habitat: Probably more widely dis tributed than indicated by isolations

Lactobacillus plautarum (Orla Jeasen) Holland. (Streptobacterium planaturum Orla-Jensen, The Lactic Acid Bacteria, Copenhagen, 1919, 174; Holland, Jour. Bact., 5, 1920, 225) From Latin planta, sprout; M. L., a plant

Probable synonyms: Bacillus pahuli acidi II Weiss, Inaug. Diss , Göttingen, 1898; Cent. f. Bakt., II Abt , 5, 1833, 599 (Lactobacillus pabuliacidi Berge) et al., Manual, 1st ed., 1923, 247); Bacillus cucumeris fermentati Hemeberg, Ztschr. f. Spiritusindustice, 26, 1903, 22, Cent f. Bakt., II Abt., 11, 1903, 160 (Lactobacillus cucumeris Bergey et al. Manual, 1st ed., 1923, 250); Bacellus wortmannis Henneberg, Cent. f. Baht, II Abt., 11, 1903, 162 (Lactobacellus wortmannii Bergey et al., Manual, 3rd ed., 1930, 288); Bacillus listeri Henneberg, Ztschr. f. Spiritusindustrie, 20, 1903, 22; Cent. f. Bakt, II Abt, II, 1903, 161 (Lactobaclerium listert van Steenberge, Ann. Inst. Past., 34, 1929, 814; Lactobacillus lister: Bergey et al, Manual, 1st ed , 1923, 248); Bacellus maercki Henneberg, loc. cit.; Bacillus leichmanni II Henneberg, loc (11, Bacıllus bergerinckii Henneberg, Ztschr f. Spiritusindustrie, 26, 1903, 22; see

Cent f. Bakt, II Abt, 11, 1903, 159 (Lactobacillus beijerinchii Bergey et al., Manual, ist ed., 1923, 243), Lactobacillus pentosus Fred, Peterson and Anderson, Jour. Biol. Chem, 48, 1921, 410, Jour. Biol. Chem, 48, 1921, 410, Jour. Biol. Chem, 48, 1921, 410, Bacterium busae asiaticae Tschekan, Cent f. Bakt, II Abt, 78, 1929, 89 (Lactobacillus busaecasiaticus Bergey et al., Manual, 3rd ed., 1930, 285), Bacterium brassea Wehmer, Cent f. Bakt, II Abt, 78, 1920, 285 (Lactobacillus busaecasiaticus Bergey et al., Manual, 3rd ed., 1930, 285), Bacterium brassicae Wehmer, Cent f. Bakt, II Abt, 10, 1903, 628 (Lactobacillus brassicae Lefevre, Abst. Bact, 6, 1922, 25)

Description from Orla-Jensen supplemented by material from Pederson, Jour

Bact., 31, 1936, 217 Rods: Ordinarily 07 to 10 by 30 to 80 microns, occurring singly or in short chains, with rounded ends Under favorable growth conditions these organisms tend to be short rods. Under adverse conditions they tend to be longer, for evample, in tomato juice agar at 45°C (Pederson, N. Y. Agr Exp Sta Tech Bull. 150, 1929) In fermenting vegetables, the organisms tend to become longer as the acidity becomes greater The organisms are usually longer in milk than in broths. Differences in morphology are well illustrated by Orla-Jensen. Non-motile Gram-positive

Gelatin-yeast extract-glucose stab Filiform growth No liquefaction

Agar slant: Growth, if any, is very faint

Broth: Turbid, clearing after a few days. A few strains flocculate Litmus mulk: Acid, usually congulated

Nitrites not produced from nitrates The majority of strains form acid from glucose, fructose, mannose, galactose, rabinose, sucrose, mattese, lactose, raffinose and salicin, and to a lesser extent, from sorbitol, mannitol, devtrin, glycerol and xylose Rhamnose, starch and inulin usually not fermented.

Lactic acid (usually inactive) with only small quantities of acetic acid and carbon dioxide is formed in the fermentation of hexose sugars Acetic and lactic acid are produced from the pentoses. Forms up to 1.2 per cent acid in broth.

This species is the inactive lactic acidproducing rod from fermenting materials but is closely related to Lactobacillus case. It ferments sucrose and maltose as readily as lactose

Salt tolerance: Usually grows in salt up to 55 per cent.

Temperature relations · Optimum temperature 30°C. Minimum 10°C. Maximum 40°C. Thermal death point 65° to 75°C for 15 minutes

Microaerophilic.

Sources from which isolated: Milk, cheese, butter, kefir, feces, fermenting potatoes, beets, carn, chard, bread dough, sauerknut, eucumber pickles, tomato pickles, cauliflower pickles and spoiled tomato products.

Habitat Widely distributed in nature, particularly in fermenting plant and animal products

10a Lactobacillus plantarum var. rudensis Breed and Pederson (not Peterson), (Jour Baet . \$6, 1938, 667.) This chromogenic organism isolated from cheese is one of two species responsible for the development of rusty spots in cheese. It is impossible to determine whether the incompletely described species Bacillus rudensis Connell. Canadian Dept of Agric , Dairying Service, Ottawa, Report for 1897, 7 is identical with this variety of Lactobacillus plantarum or with Lactobacillus brevis var rudensis (see species No. 121) This chromogenesis is produced in starch media under anaerobic conditions.

Lactobacillus Ielchmannii Bergey
 Edacillus Ielchmannii I, Henneberg
 Ztschr. f. Spiritusindustrie
 26, 1903, 22; see Cent. f. Bakt., II Abt., II, 1903, 163; Bergey et al
 Manual, 2nd ed
 1925, 180 ) Named for Prof. G. Leichmann
 Cerman beterrologist

Probable synonym · Bacillus leichmanni III, Henneberg, loc eit

Rods: 0.6 by 20 to 40 microns, occurring singly and in short chains. The cells show two or more deeply-staining granules Non-motile Gram-positive. Gelatin stab · No liquefaction.

Agar colonies Small, clear with white centers.

Agar slant. Limited, grayish streak, better growth in stab

Broth. Turbid.

Nitrites not produced from nitrates. Acid from glucose, fructose, maltose, sucrose, trehalose, and slight amounts from galactose, mannitol and α-methylglucoside. Lactose, raffinose, arabinose, rhamnose, dextrin and inulin not fermented. Forms 13 per cent lactic acid ın mash

Optimum temperature 36°C. Maximum 40° to 46°C

Microaerophilic

The species is apparently similar to Lactobacillus delbrueckii but has a lower optimum temperature

Source From compressed yeast and from fermenting milk

Habitat Dairy and plant products

12 Lactobacillus brevis (Orla-Jensen) Bergey et al. (Bacillus v. v. Freudenreich, Landw Jahrb. d Schweiz, 1891, 22, Bacillus casei y, v Freudenreich and Thoni, Landw Jahrb d Schweiz, 1904. 526, also Orla-Jensen, Cent f. Bakt, II Abt , 13, 1904, 604, Betabacterium breve Orla-Jensen. The Lactic Acid Bacteria, 1919, 175, Bergey et al., Manual, 4th ed., 1934, 312 ) From Latin brevis, short.

Probable synonyms Bacillus brassicae fermentatae Henneberg, Ztschr f Spiritusindustrie, 26, 1903; Cent f Bakt., II Abt., 11, 1903, 167 (Lactobacillus fermentatac Bergey et al , Manual, 1st ed , 1923, 252), Bacillus panis fermentati Henneberg, Ztschr f Spiritusindustrie, 25, 1903, Cent. f Bakt, II Abt., 11, 1903, 168 (Lactobacillus panis Bergey et al , Manual, 1st ed , 1923, 251), Bacillus acidophil-aerogenes Torrey and Rahe. Jour Inf. Dis., 17, 1915, 437 (Lactobacil-

lus acidophil-aerogenes, Holland, Jour. Bact., 5, 1920, 216); Lactobacillus pentoaceticus Fred, Peterson and Davenport, Jour. Biol. Chem., 39, 1919, 357; Peterson and Fred, ibid., 42, 1920, 273; Lactobacillus pentoaceticus var. magnus Iwasaki, Jour. Agr. Chem. Soc. Japan, 16, 1910, 148. Lactobacillus lycopersici Mickle, Abst. Bact., 8, 1924, 403; Mickle and Breed, New York Agr. Exp. Sta. Tech. Bull. 110, 1925; Pederson, ibid., Tech Bull. 150 and 151, 1929; Bacterium soya Saito, Cent. f. Bakt., II Abt., 17, 1907, 20 (Lactobacillus souae Bergey et al., Manual, 1st ed., 1923, 251).

Bacillus caucasicus von Freudenreich, Cent. f. Bakt., II Abt., 3, 1897, 135 and Betabacterium caucasicum Orla-Jensen, The Lactic Acid Bacteria, 1919. 173 were isolated from kefir grains and considered to be the organism Kern isolated in 1882. They are gas-producing lactobacilli but are less active toward sugars than Lactobacillus brevis.

Description supplemented by material from Pederson, Jour. of Bact , 35, 1938, 105.

Rods: 0.7 to 10 by 2.0 to 40 microns, with rounded ends, occurring singly and in short chains, and occasionally in long filaments which may show granulation

Non-motile. Gram-positive. Gelatin: No liquefaction.

Agar slant Growth, if any, faint Broth: Turbid, clearing after a few

Milk · Acid produced but no clot except with some freshly isolated strains

Does not attack casein as a rule.

Is able to utilize calcium lactate as a source of carbon.

Acid from arabinose, xylose, glucose, fructose, galactose and maltose. Streuss vary in fermentation of lactose, sucrose, mannose and raffinose Salicin, mannitol, glycerol, rhamnose, destrin, inulia and starch seldom fermented. Usually shows a particularly vigorous fermentation of arabinose.

Lactic acid usually inactive; acetic acid, ethyl alcohol and carbon diovide formed in formentation of aldohaveses Mannitol produced from fructose. Acctic and lactic acid produced from the nentoses.

This species includes the large group of gas-producing lactic acid rods ordinarily characterized by a marked fermentation of pentoses, particularly arabinose. They usually also ferment fructose more readily than glucose

Temperature relations Ontumum 30°C. Growth poor below 15° and above 37°C

Maximum 38°C

Source: From milk kefir cheese. feces, fermenting sanerkrant, ensilage, manure, soils, sour dough, and spoiled tomato products

Habitat : Widely distributed in nature. particularly in plant and animal products

12a. Lactobacullus brems var. rudensis Breed and Pederson (Lactobacullus rudensis Davis and Mattick, Proc Soc Agr. Bact., 1936, 3 (this organism is presumably the same as Bacillus rudensis Davis and Mattick, Jour. Dairy Res , 1, 1929, 50): Breed and Pederson (not Peterson), Jour Bact., 36, 1938, 667.) This chromogenic variety isolated from cheese is a causative agent in the production of rusty spot in cheese From a study of cultures, it is regarded as a chromogenic variety of Lactobacıllus brevis See also species No 10a.

13 Lactobacillus buchneri (Henneberg) Bergey et al. (Bacillus buchners Henneberg, Cent. f. Bakt. II Abt. 11, 1903, 163, Bergey et al , Manual, 1st ed , 1923, 251.) Named for Prof E. Buchner, a German bacteriologist

Probable synonyms · Bacillus wehmeri Henneberg, Cent f Bakt, II Abt, 11, 1903, 165 (Lactobacillus wehmers Bergey et al , Manual, 1st ed , 1923, 249), Bacillus hayducki Henneberg, Cent Bakt., II Abt , 11, 1903, 163 (Lactobacillus hayduckı: Bergey et al., Manual, 1st ed , 1923, 253); Bacterium mannitopoeum Muller-Thurgau, Cent. f. Bakt , II Abt., 20, 1908, 396; tbid., 56, 1912, 129; tbid., 48. 1917 (Lactobacillus mannitonoeus Pederson, New York Agr Eyn, Sta. Tech. Bull. 150 and 151, 1929 Lactohacillus mannilonaeus var fermentus Iwasaki, Jour Agr. Chem. Soc. Japan 16, 1940, 148)

Description supplemented by material from Pederson, Jour Bact., 35, 1938, 107. Rods 0 35 by 0 7 to 4 0 mierons occurring singly, in pairs and chains or in filements 25 microns or longer. Non-motile.

Gram-positive. Agar colonies . White to vellowish ad-

herent Agar slant Growth, if any, faint,

Broth: Turbid, clearing after a few dove

Latmus milk. Usually unchanged but may be slightly acid with no reduction. Natrites not produced from nitrates

Acid usually from arabinose vylose glucose, fructose, galactose, mannose. sucrose, lactose, maltose and raffinose, Manutol, sorbitol, giveeral, rhampose, salicin, inulin, dextrin and starch fermented by a few strains

Lactic acid usually inactive. Acetic seed, ethyl alcohol and carbon dioxide formed in the fermentation of aldo-Mannitol produced from fructose. Acetic and lactic acid from nentoses

Strains of this species might be considered intermediates between Lactobacillus breits and Lactobacillus fermenti. Forms 1 3 per cent lactic acid in mash

and 27 per cent alcohol. Optimum temperature 32° to 37°C. Minimum 10° to 15°C. Maximum 44° to 48°C.

Source: From sour mash, pressed yeast, molasses, wine, catsup and sauerkraut. Habitat Widely distributed in fermenting substances

14, Lactobacillus pastorianus (Van Laer) Bergey et al. (Saccharobacillus pastorianus Van Laer, Cont. l'Histoire des Ferments des Hydrates de Carbone, Acad. Roy. de Belge, 1892; Bacillus pastorianus Macé, Traité Pratique de Bact . 4th ed., 1901, 957; Lactobacterium pastorianum van Steenberge, Ann. Inst. Past., \$4, 1920, 816; Bergey et al., Manual, 1st ed., 1923, 246.) Named for Pasteur. French chemist; from Latin pastor, a herdsman.

Probable synonyms: Saccharobacillus pastorianus var. berolinensis Henneberg. Cent. f. Bakt, II Abt., 8, 1902, 186 (Lactobacillus berolinensis Bergey et al., Manual, 1st ed , 1923, 246); Bacillus lindneri Henneberg, Wochnschr, f. Brauerei, 18, 1901, No. 30; Cent. f Bakt., II Abt., 8, 1902, 184 (Lactobacillus lindneri Bergey et al., Manual, 1st ed., 1923, 245); Bacillus fasciformis Schönfeld and Rommel, Wochnschr. f. Brauerei, 19, 1902, No. 40; abst. in Cent. f. Bakt., II Abt., 9, 1902, 807 (Saccharobacillus berolinensis fasciformis Henneberg, Handb. der Gärungsbakteriologie, 2, 1926, 123; Bacillus belorinensis (sic, evidently intended for Bacillus berolinensis) Otani, Cent. f. Bakt., II Abt , 101, 1939, 149).

Description supplemented by material from Henneberg, Cent f. Bakt., II Abt., 8, 1902, 184; Shimwell, Jour Inst. Brewing, 41, 1935, 481, and Pederson, Jour Bact . 85, 1938, 107.

Rods. 0 5 to 1 0 by 7.0 to 35.0 microns. occurring singly and in chains Nonmotile. Gram-positive.

Gelatin colonies. No growth

Beer wort gelatin stab. Beaded to arborescent growth.

Beer wort agar colonies. Small, gray, raised, filamentous.

Agar slant Little or no growth: better in stab.

Broth: Good growth in yeast extract.

Litmus milk Acid.

Nitrites not produced from nitrates.

Acid from arabinose, glucose, fructose, galactose, maltose, sucrose, dextrin, raffinose, trehalose and mannitol and slightly from lactose and starch. No acid from xylose, rhamnose or inulin. Forms 15 per cent acid in mash. Also forms CO2 and alcohol, lactic, formic and acetic acid.

The species includes the ordinarily long rod types from spoiled beers. Apparently the same variations in regard to sugar fermentation may be found as are noted for similar species.

Optimum temperature 29° to 33°C. Minimum 11°C. Maximum 37°C.

Microaerophilic.

Source: From sour beer and from distillery yeast.

Habitat: Probably more widely distributed than indicated by isolations.

15. Lactobacillus fermenti Beijerinck. (Beijerinck, Arch. néerl. d. sci. exactes et nat., Sér. 2, 7, 1901, 212; Smit, Ztschr. f. Garungsphysiol., 5, 1916, 273; Lactobacterium fermentum van Steenberge, Ann. Inst. Past., 34, 1920, 816.) From Latin fermentum, ferment, yeast.

Probable synonyms: Bacillus 8, von Freudenreich, Cent. f. Bakt, II Abt, 1, 1895, 173; also Landw. Jahrb d. Schweiz, 1895, 211; Bacillus casei &, von Freudenreich and Thöni, Landw. Jahrb d. Schweiz, 1904, 526; also Orla-Jensen, Cent. f. Bakt., II Abt., 13, 1904, 609; Betabacterium longum Orla-Jensen, The Lactic Acid Bacteria, 1919, 174 (Lactobacıllus longus Bergey et al., Manual, 4th ed., 1934, 312); Bacterium gayonu Muller-Thurgau and Osterwalder, Cent i Bakt., II Abt., 48, 1917, I (Lactobacellus gayonii Pederson, New York Agr. Exp Sta. Tech. Bull. 150 and 151, 1929); Bacterium intermedium Muller-Thurgau and Osterwalder, Cent. f. Bakt, II Abt, 48, 1917, 1 (Lactobacillus intermedium Bergey et al., Manual, 3rd ed., 1930, 295); Bacillus aderholdi Henneberg, Cent. f. Bakt , II Abt., 11, 1903, 166.

Description supplemented by material from Pederson, Jour. Bact., \$5, 1938, 196. Rods Variable, usually short (Beije-

rinck), 0.5 to 1.0 by 3.0 to 150 microus (Smit), sometimes in pairs or chaus-Non-motile. Gram-positive (Smit)-

Yeast extract-glucose-gelatin: Filiform, no liquefaction (Pederson). Agar colonies: Flat, circular, small,

translucent like droplets of water.

Agar slant: Growth, if any, scant. Broth. Turbid, clearing after a few

Milk: Unchanged or slightly acid.

Nitrites not produced from nitrates Reduction of litmus, methylene blue, indigo carmine, sodium thiosulfate Na.SO, is reduced to H.S. (Smit)

Acid usually from glucose, fructose, maltose, sucrose and lactose (Beyerinck) and mannose, galactose, and raffinose, some strains ferment xylose, usually does not ferment arabinose, rhamnose, sorbitol, mannitol, inulin, devtrin, starch or saliein (Pederson).

Lactic acid, usually mactive; acetic acid, ethyl alcohol and carbon droude are formed in the fermentation of aldebroses (Smit), (Pederson). Mannitol is formed in the formentation of fructose (Beyerinck), (Smit). Acetic acid and lactic acid are produced from pentoses if they are fermented (Pederson).

These are the higher temperature gasproducing rods. They usually do not ferment the pentoses but when they do, the fermentation is seldom as active as that produced by strains of Lactobacillus brevis.

Temperature relations Optimum 41° to 42°C. Minimum 15° to 18°C. Maximum 48° to 50°C.

Microaerophilic.

Source: From yeast, milk products, fermenting dough, potatoes or vegetables, tomato products and wine.

Habitat · Widely distributed in nature, particularly in fermenting plant or animal products.

Appendix I: The following species probably should be included in the genus Lactobacillus. Many are duplicates of the species described in full, but the majority are so poorly characterized that they cannot be properly identified.

Acidobacterium aerogenes Schlirf. (Stabchen Ka, Heim, Cent f. Bakt., I Abt., Orig., 33, 1924, 252, Schlirf, Cent. f. Bakt., I Abt., Orig., 97, 1925, 114; Plozamobacterium aerogenes Lehmann, in Lehmann and Neumann, Bakt. Diag. 7 Aufl., 2, 1927, 509) Possibly Lactobacillus breus Bergey et al. Produces acid and gas from glucose. From dental earies, mouth cavity and intestine.

Acidobacterium lacfis Heim. (Heim, quoted from Schlirf, Cent. I. Bakt., I Abt., Orig., 97, 1925, 113.) Schlirf says that this species is probably identical with Bacillus necrodentalis Goadby, Regarded by Lehmann (in Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 597-508) as identical with Bacillus acidophilus Moro; or it may be identical with Streptobacterium casic Orla-Jensen From dental caries, deposit on tongue and in intesting.

Acidobacterium moro Schlirf. (Stabchen Ke, Heim, Cent. f. Bakt, f. Abt., Orig, 93, 1924, 252, Schlirf, Cent. f. Bakt, I. Abt., Orig., 97, 1925, 114 Plocamobacterium moro Lehmann, in Lehmann and Neumann, Bakt. Dig., 7 Aufl., 2, 1927, 508) From the intestine. Similar to Acidobacterium lactiz. Kuchunka (Cent. f. Bakt, I. Abt., Orig. 144, 1939, 370) reports this organism as occurring in two cases of menuntitis.

Bacillus bifidus aerobius Heurlin. (Bakt Unters d Keimgehaltes im Genitalksande d feberarden Wöchnerinnen Helsinfors, 1910, 93) From the genital canal Resembles Bacillus bifidus communis Tissier

Bacıllus bifidus capitatus Heurlin. (Bakt Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wöchnerinnen Helsingfors, 1910, 175.) From the genital canal.

Bacellus carpathiens Kindraizuk. (Oesterr. Molketei Zeit., 29, 1912, 257.)

Arranged by Prof. C. S. Pederson, New York State Experiment Station, Geneva, New York, March, 1945

From the sour milk of the Carpathian region. Presumably Lactobacillus bulgaricus.

Bacillus circularis minor Heurlin. (Bakt Unters d. Keimgehaltes im Genitalkanale d fiebernden Wochnerinnen Helsingfors, 1910, 170) From the genital canal. Anaerobic.

Bacillus necrodentalis Goadby. (Goadby, Microorganisms in dental caries, Dental Cosmos, 42, 1900, 213) From dental caries

Bacillus orenburgii Horowitz-Wlassowa. (Cent f Bakt, II Abt., 64, 1925, 338.) From kumys (Caucasus). Presumably Lactobacillus bulgaricus.

Batchinsky, Arch d Gesellsch, d. Naturf St Petersburg, 42, 1911; quoted from Horowitz-Wiassowa, Cent f Bakt., II Abt, 64, 1925, 330.) From kumys in Ufa (U S S R) Presumably Lactobacillus bulgaricus.

Bacillus sardous Grixoni. (Annali di Med Navale, 112, 1905, 223 and Cent. f. Bakt, II Abt. 15, 1905, 951, Bacterium sardum miciurati Biauco, II Cesalpino, 8, 1912, 33) Prom gioddu (Sardima). Presumably Lactobacillus bulgaricus.

Bacıllus vagınac Kruse (Scheidenbacillen. Doederlein. Das Scheidensekret und seine Bedeutung fur das Puerperalfieber, Leipzig, 1892, 32; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 358; Bacillus vaginalis longus Heurlin, Bakt Unters d Keimgehaltes im Genitalkanale d fiebernden Wochnerinnen. Helsingsfors, 1910, 170; Bacıllus vanınalıs Jotten, Arch f Hyg, 91, 1922, 149, Stäbchen Ke, Heim, Cent f Bakt, I Abt , Orig , 93, 1924, 252; Acidobacterium doederleinii Heim, quoted from Schlirf, Cent f Bakt, I Abt, Orig, 97, 1925, 104; Plocamobacterium vaginge Lehmann, in Lehmann and Neumann, Bakt Diag, 7 Aufl , 2, 1927, 510, Lactobacillus doederlein Gillespie and Rettger, Jour. Bact., 56, 1938, 623 ) Kruse (Allgemeine Mikrobiol., 1910, 287) considers this species a "langen Milchsaurebacillus" all of which he would group under the name

Bacillus lacticus (not Bacillus lacticus Kruse, in Flugge, Die Mikroorganismea, 3 Aufl., 2, 1896, 356 as this is Streptooccus lactis Löhnis). Jotten (loc. cil.) sad Thomas (Jour. Inf. Dis., 43, 1932, 218) consider this species identical with Lactobacillus acidophilus (Moro) Holland. From the secretion of the normal varena. See Bacillus crassus Lipschüt

Bacterium gracile Muller-Thurgu (Cent. f. Bakt., II Abt., 29, 1998, 396, Muller-Thurgua and Osterwalder, that, 39, 1912, 157; ibid, 48, 1917, 1; Lacto bacillus gracile Bergey et al, Manual, 3rd ed., 1930, 297.) This organism which was isolated from wine is probably not a lactobacillus. It may belong to the genus Leuconotoc (subculture examined in 1936. C. S. Pederson).

Bacterum granulosum Lehmann and Neumann. (Körnchenbacillus, Luersen and Kuhn, Cent. f. Bakt., I Marsen, 1907, 241; Lehmann and Neumann, Bakt. Diag, 5 Aufl., 2, 1912, 306.) From yoghurt (Bulgaria). Presumably Lactobacillus bulgaricus.

Bacterium lactis commune Hohennadel. (Arch. f. Hyg., 85, 1916, 237.) From feces Similar to Lactobacillus acidophilus (Moro) Holland

Bacterium mann Weigmann, Grabet and Huss (Milchsaurebakterium sus Mazun, Düggeli, Cent. f. Bakt, II Abt, 15, 1905, 595; Weigmann et al., Cent i. Bakt., II Abt., 19, 1907, 78) From mazun (Armenia). Presumably Lachbactillus bulacricus.

Bacterium vermiforme Ward (Phil. Tran. Roy Soc. London, 183, 1892, 19; Bacillus vermiforms Migula, Syst. 4 Bakt., 2, 1900, 652; Betabacterium temiforme Mayer, Inaug. Diss, Univ. Utrecht, 1938.) Originally isolated from the ginger beer plant fermentation This is presumably a slime forming lactobacillus.

Bacteroides aerofaciens Legerth and Bacteroides biformis Legerth (dour Bact, 50, 1935, 282-283.) From fees Possibly lactobacilli but their relationships are not definitely known. Lactobacillus betadelbrueckii Kitahara (Bull Agr. Chem Soc. Japan, Tokyo, 16, 1910, 123.) From cercal mash

1910, 123.) From cereal mash
Lactobacillus caneus Kitahara (lor
cit.). From cereal mash

Lactobacillus ciliatus Kitahara (lac

Lactobacillus enzymothermophilus Buck. (Amer. Jour Pub Heilth 32, 1912, 1230) A thermophilic igrowth at 52° and 62°C) presumalit spore forming bacillus isolated from pisteuried milk

Lactobacillus fructororans Charlton, Nelson and Werkman (low) State Coll. Jour. Sci., 9, 1931, 1) I rom silid dressing. Similar to Lactobacillus breits

Lactobacillus hilgardi; Dougles and Cruess (Food Research, 1, 1979, 113) This organism was soluted from wind is not completely described and so can not be compared with previously described success.

Lactobacillus hyochi Otani Laetobacil lus hyochi var. 1, Otani, Laetobacillus hyochi var. 2, Otani, Laetobacillus hyochi nentorus Otani, Laetobacillus aletobal philia Otani, Indi Laetobacillus apprapries Otani, "Otani Faculty of Nerilokkaido Imp. Univ. 32, 1935, 21 Diese organisms were isolited from rice With the possible exception of the list type, they are probably destricti with Laetobacillus plantarum or closely related species.

Lactobacilla odontolyticus Rodrigues (Bacillus acufanhilus odontolyticus I and II, McIntosh Junes and Lazarus Burlon, Brit Jour Lyn Med and Path 3, 1922, 141; Bacillus aculaphilus odonto lyticus, abid , 115, Lactobacillus estonto lyticus and Lactobacillus odontolyticus Types 1, 11 and 111, Reslinguez, Military Dent. Jour., 5, 1922, 206, Bacilles win teleticus Melntosh, James and Larrus Parlon, Best. Jour Day Med and Path 8, 1921, 178; Bacillus aculophilus of m Intitious Rosebury, Lanton and Buch birder, Jour Buct . 18, 1973, 205 . Lact torilles whom lyticus I and II. Toples and Wilson, Princ Back, and Immura 2: ded, 1936, 588.) From dental carree

Type I resembles and is possibly identical with Bacillus accolophius Moro and Desclerlen's breillus (Bacillus regimes bruse! See Resebury, Bact. Rev., 8 1944, 183 and Arch of Path, 53, 1941, 413 Type II shous considerable plonmorphism, short coccal forms appearing in the more alkaline media (McIntoch, James and Lazarus-Barlow, Brit Jour. 1 pp Med and Path, 6, 1924, 183). Types I, II and III of Rodriguez (loccal) do not correspond with Types I and II of McIntoch et al or with the groupings of Howe and Hatch (Jour Med Res., 26, 1917, 184).

Lactobacillus panis acidi Nikoliev (Wrss Forschungsinst Rikerei indust, 1 S R B 5, 1933, 3-11.) Four isolii ins from breid dough designated by the Greek letters, a. B. 21 and 22

Lactobacillus sake Katagiri, Kitahara, takama and Sugase (Bull Agric Chem Soc Japan, 10, 1931, 153) From mush used in the manufacture of sake Samdar to Lactobacillus plantarum.

Lactobacellus rolovus Kitahara (Bull. Agr. Chem. Soc. Japan, Tokyo, 16, 1910, 121 i. Trom cercil mash.

Lactification accounts van Steenberge (Ann Inst Past, 54, 1920, 86) Lean beer

Lactibact-rum conglomeratum van Steenberge (loc est., \$12). From beer-

Lactobacterium filatim van Steenberge der eit, 512). From beer wort

Lact hacterium feerogenum von Steen beige die est. 82). From heer with Lacthacterium grace von Steenberge

the cit, 811) From beer wort

Lact bacterium multivolatieum van
preenberge floc cit, 811) From beer-

nort Lactificationum multivalitejenum van Steenberge (b.e. ed., 812). From beer-

Lact determine object the early sin singlesteed ergo, the early Mill Trust beerwort.

wort.

Lactobacterium parcifermentans van Steenberge (loc. cit., 812) From beerwort.

Lactobacterium terricola van Steenberge (loc. cit., 806). From garden soil.

Lactobacterium viscogenum van Steenberge (loc cit, 814). From beer-wort. Streptobacillus lebenis Rist Khoury. (Rist and Khoury, Ann. Inst. Past., 16, 1902, 70; Bacillus lebeni Kuntze, Cent. f. Bakt , II Abt., 21, 1908, 744, Streptobacillus lebensis a and B Lohnis, Cent f. Bakt., II Abt , 22, 1909, 553; Streptobacillus lebenis viscosus and Streptobacillus lebenis nonviscosus Scverin, Cent f. Bakt, II Abt., 24, 1909, 488; Bacterium Ichenis Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 308) From leben (Egypt and Near East) Presumably Lactobacillus bulgaricus

Streptothrix dadhi Chatterjee (Cent. f Bakt, I Abt, Orig, 53, 1910, 111.) From sour milk (dadhi) of India Presumably Lactobacillus bulgaricus.

Thermobacterium juguri Orla-Jensen (Yoghurt bakterium, Kuntze, Cent. f Bakt, II Abt., 21, 1908, 737, Orla-Jensen, The Lactic Acid Bacteria, 1919, 161; Lactobacillus juguri Holland, Jour. Bact., 6, 1920, 225.) From jughurt (Bulgaria). Presumably Lactobacillus bulgarieus.

Thermobacterium mathiacolle Cecilia. (Le Lait, 20, 1940, 385-390) From sweetened condensed milk. Possibly a spore-former

Appendix II:\* The genus Leptotrichia Trevisan, 1879 is no longer recognized as a valid genus While the confusion with Leptothriz Kutzing, 1843 was corrected by Trevisan's work, the identity of the type species, Leptotrichia buccalis, is uncertain Few of the species that have been placed in Leptothriz and Leptotrichia are well enough described to be recognized with certainty

All descriptions of Leptotrichia buccalis published earlier than 1886 are based on microscopic observations only. This is also true of the three species of Laptothrix recognized by Miller (Die Mikmorganismen der Mundhohle, Leipzig, 1889, 69-80). The species that he distinguished in this way are recognized in the seven editions of Lehmann and Neumann's Bakteriologische Diagnostik published from 1896 to 1927. Chester (Manual Determ. Bact., 1901, 371) also follows Miller's ideas in regard to the nature of the species of Leptothriz These authors felt that the identity of the true Leptotrichia buccalis was doubtful.

On the other hand, Vignal (Arch. de Physiol. norm. et path., 8, 1886, 337) isolated what he thought to be this organism, and it is his description that is used with minor changes by Eisenberg (Bakt Ding., 3 Aufl., 1891, 134), Miguli (Syst. d. Bakt., 2, 1900, 445) and in all editions of Bergey's Manual (1923-1939) up to the present edition. A study of Vignal's work shows, however, that the filamentous organism that he isolated and grew readily in broth, agar and gelatin cultures was in all probability one of the common spore-formers. It grew but rarely on the plates inoculated with material from the mouth. As is clearly shown in his drawing and descriptions, it liquefied gelatin rather quickly with the formation of the characteristic wilekled pellicle of a spore former Soon after, Arustamow (Wratsch, 1859, Nos-3 and 4; abstract in Cent f. Bakt. 6, 1889, 349) isolated a similar acrobic, filamentous organism that grew readily at 37°C on agar and gelatin, but he also noted large numbers of very tiny colonies of a microaerophilic bacterium which may have been the lactobacilli or lactobacilli-like organisms of later authors. Even recent excellent reviews of the

<sup>\*</sup> Completely rearranged by Prof. Robert S Breed and Prof. Carl S. Pederson, New York State Experiment Station, Geneva, New York, March, 1945.

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Some introduction, Fig. 24 Head (Sittler & rayer-ie. or in Erland for 122-22, 11 : 2 :21, and his co-review, were the third streptor as the case of death money Others following the jone of the party of the Dental &e., 27, 2525, 2- 122 455 124 Wheny and Ourse the Let Line 12. 1916, 26) territored the more experient Organists of the service Gottle positive, Francis DE 2 1 1 me me that grow his business Est erea here it is tot Elegative cost whether the light and product Economics quipylin of any and it is an expense and Lazzrackie w Brand Joseph Exper. Paris, 2, 200 145 or the low and produce of the Land or metro to cults Thirties & L and 25 of rods really represent the Landing to make of early district Some observers e 8, Berney on Deer Jose 1925, 29, here for administration at transition of the street at the street terach, as Lycer one 1 -confu arroad ing to Read - 27

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The type speries is Larrarrelia barrate (Robin Transa)

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Leptothrix falciformis Beust. (Dental Cosmos, 50, 1908, 594; Jour. Dent. Res., 16, 1937, 379) From the mouth.

Leptothriz fittforms Castellani and Chalmers. (Bacillus (Leptothriz?) pyognes fittforms Flexner, Jour. Exp. Med., 1, 1896, 211; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1063.) From the genital tract and thoracic cavities of a rabbit with an acute pleuritis, pericarditis, pneumonia and acute endometritis. Gram-negative. Not regarded as identical with Bacillus piliforms Tyzer (Jour. Med. Res , 37, 1917, 307) which is a spore-former.

Leptothriz gigantea Miller (Miller, Ber d. deutsch bot. Gesell., I, 1883, 221; Leptotrichia gigantea Trevisan, I generi e le specie delle Batternacee, 1889, 10; Rasmussenia gigantea De Toni and Trevisan, in Saccardo, Syllege Fungorum, 8, 1889, 930.) From pyorthæa in dogs, swine and sheep. This name was apphed to a mixture of species.

Leptothrix haemoglobinophila sporulens Mackenzie (In System of Bact, Med. Res. Council, London, 8, 1931, 99) From cerebro-spinal fluid. A Gram-negative spore-former.

Leptothrix innominata Miller. (Die Microrganismen der Mundholle, 1889, 51, Leupzig; Pseudoleptothrix innominata Prévot, Ann Inst Past, 60, 1938, 301) Prévot (loc. ett) regards this species as type for his new genus Pseudoleptothrix Proposed to include all filamentous forms from the mouth that resemble Leptothrix buccalis (Nobin

Leptothrix insectorum Robin (Histoire naturelle der végétaux parasites, Paris, 1853, 354) From the rectums of insects.

Leptothriz mazima buccolis Miller. (Miller, Deutsche med Wehnschr , 14, 1888, 612; Leptotrichia mazima Trevisan, Igeneri e le specie delle Batteriacee, 1889, 19; Rasmussenia mazima De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 930; Leptothriz buccolis Chester, Man. Determ Bact., 1901, 371; Bacillus Man. Determ Bact., 1901, 371; Bacillus

maximus Goadby, Mycology of the Mouth, 1903, 191.) From the mouth

Leptothvir parasitica Kutzing. (Kützing, Bot. Zeitg., 1847, 220; quoted from Winter, in Die Pilze, Rabenborste Kryptogamen Flora, 2 Aufl., 1, 183, 57; Bacterium parasiticum Billet, Boll Sci. de la France et de la Belgique, Para, 21, 1830, 190.) From a brownish deposit on alexae.

Leptothriz preputialis Vicentiai. (Atti Accad. Med. Chir. di Napoli, A. 1890-91, quoted from Vicentini, Bateris of the Sputa. Trans. by Stuter and Saieghi, London, 1897, 89.) From the urethra.

Leptothrix pyogenes cuniculi Musertello. (Museatello, 1899, quoted from Nannizzi, in Pollacci, Tratt. Micopat Umana, 4, 1934, 57; Leptotrichia esniculi (cic) Nannizzi, ibid., 57.) From spontaneous suppuration in a rabbit.

Leptothrix racemosa Vicentini.
(Vicentini, Atti d. r. Accad. Med Chir
di Napoli, 46, 1892, 459; Leptotrichis
racemosa Nannizzi, in Pollacci, Trait.
Micopat. Umana, 4, 1834, 55.) From
the mouth. Conidia-like bodies an
described. See Vicentini, Bact. of the
Sputa, Eng. Trans. by Stuter and Saieghi,
London, 1897 and Williams, Denial
Cosmos, 41, 1899, 330.

Leptathriz racemosa (incenti (sic)
Mackenzie. (Leptathrix, Matthess,
Pract , 74, 1905, 197; Mackenzie, in
System of Bact., Med. Res. Council,
London, 8, 1931, 94.) From localized
empyema. Appears to be the same
so Vicentini's organism.)

Leptothrix vaginalis Donné (Donné, quoted from Nannizzi, in Poblacci, Tati Micopat. Umana, 4, 1934, 56; Leptotrichia vaginalis Nannizzi, ibid., 56.) Saprophyto from the vagina.

Leptothriz vaginalis von Hem (Ueber Scheidenmykosen, Samml. Lin Vortr. n. F., 1895, No. 137.) From a case of vaginal mycosis.

Leptathriz variabilis Rasmussen (Rasmussen, Om Dryckning of Mero organismer fra Spyt of sunde Mannesker, 1883; Leptothriz II, Zopf, Die Spaltpilte, 3 Aufl., 1885, 107; Leptotrichia ieriabilis Travisan, I generi e le specee delle Batteriacae, 1889, 10; Rasmusenna carabilis De Toni and Travisan, in Saccado, Sylloge Fungorum, 8, 1889, 931) From colline

Resmussenia anceps De Toni and Trevisan. (Leptohriz I, Rasmussen, Om Dryckning of Microorganismer fra Spyt of sunda Mannesker, 1853, Bacteriopsis communescen Trevisan, Romen et al., 1853, 1854, 1855, 1855, 1856, Bactelia rasmussen Trevisan, I, genera e le specie delle Batteriacee, 1859, 15; De Toni and Trevisan, Romen et al., 1859, 1850, 18

Appendix III: Many species of angerobic. Gram-positive, non soore-forming, largely parasitic rods have been de acribed. These are similar to many water to the species included an Lactabacillus Prévot has arranged these in the following cenera. Several are madequately studied and searcely deserve recognition. Some as indicated may belong in other genera, e.g., spore formers belonging in genus Clostridium species produce gas in sugar broths or have other characteristics (e.e. motility) that are unusual for the families that include Gram-positive, non-spore form ene mele.

#### Genus I Enbacterium Prérot (Ann. Inst. Past , 60, 1938, 294)

Non motile, straight or curved rosts Vaully occurring singly, in pairs of very short chains. Never show branching Not capsulated. Geom-positive Angendate

1 Eufactersum foedans (blein) Prévot (Bacellus foedans Elem, Laucet, 1, 1908, 1832; Prévot, Ann. Inst. Past, 60, 1938, 294) From salted

2 Eubocterum messi (Hauduroy et al. Prévot (Anacrobe Bacillus, Niosi; al.) Prévot (Anacrobe Bacillus, Niosi; al.) Prévot, Ong. 58, 1911, 193, Bacteroules messi Hauduroy et al., Diet d Bact. Path., 1937, 65; Prévot, Ann Inst Past, 60, 1938, 291) From suppurputure pleuritis

3 Eubacterium rectale Prévot. (Un bacille amérobie, Grooten, Compit rend, Noc Biol, Paris, 102, 1922, 43; Bacteroides rectalis Hauduroy et al., Diet. of Bact Path, 1927, 72; Prévot, Ann. Inst Past, 60, 1938, 294) From rectal uter.

4 Enhacterium obiti Prévot (Bacilius B, Obst, Jour Inf Dis., 24, 1919, 159 and 165, Prévot, Ann Inst Past, 6, 1938, 291) From stomach of sardines and from their food (small crustaceans)

- 5 Enhacterium quartum Prévot (Amerob No IV, Rodella, Ztachr. f. Hrg. 41, 1902 474, Prévot Ann Inst Past 60, 1938, 291 : I rum intestine of a child
- 6 Eubocterum guntum Prévot.

  Imerob No V, Rodelli, Ztechr f
  Hyg. 41, 1962, 175, Prévot, Man de Class et Determ Monographie Inst Part, 1910, 65). From intestine of a child
- 7 Lubneterium ethilirum Prévot (Bacillus gravitis ethylirus Veladine and Rosenthal, Compt rend Soc Biol, Paris, 57, 1996, 1925, Prévot, Ann. Inst. Part., 60, 1938, 295.). From a human stomach.
- S Lubacterium codorers Prévot (see Bacillus cadavers but;rieus Buday). No sporce observed
- 9 Eubacterism tortionum (Debina) Prévot (Pacillas tortionum Debina, Cent f Bakt, I Mr Ong, cz. 1912, 233, I externées tortionut Borges et al., Minual, let ed. 1923-229, Prévot, Ann

<sup>\*</sup> Arranged by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1945

Inst. Past., 60, 1938, 295.) From human feccs.

- Eubacterium aerofaciens (Eggerth)
   Prévot. (Bacteroides aerofaciens Fggerth, Jour. Bact., 30, 1935, 282;
   Prévot.
   Ann. Inst. Past., 60, 1938, 295.)
   From human feces.
- Eubacterium biforme (Eggerth)
   Prévot. (Bacteroides biformis Eggerth,
   Jour Bact., 30, 1935, 283; Prévot, Ann.
   Inst Past., 60, 1938, 295.) From human
   Ieces.
- 12. Eubacterium Iimosum (Eggerth)
  Prévot. (Bacteroides Iimosus Eggerth)
  Jour. Bact, 30, 1935, 200; Prévot, Ann.
  Inst. Past, 60, 1938, 295) From human
  leces. Pederson (Jour Bact., 60, 1916,
  478) secured a culture of this species from
  Eggerth, and found that it fermented
  glucose with the production of higher
  fatty (presumably butyric) acids and
  lactic acid. The species should probably
  be placed in Butyrbacterium Barker,
  13. Eubacterium discipramas (Mas-
- Bubacterium discijormans (Massin) Prévot. (Bacillus discijormans Massin, Zischr f gesammte Exp. Med., 2, 1913, 81. Prévot, Ann Inst Past., 60, 1938, 295) From respiratory system and skin
- 14 Eubacterum poeciloides (Roger and Garnier) Prévot (Bacillus poeciloides Roger and Garnier, Bull et Mem. Soe Méd. des Hôpitaux Paris, 2, 1906, 870; Prévot, Ann Inst. Past., 60, 1938, 295) From intestine
- 15 Eubacterium typhi czanthematici Prévot (see Corynebacterium typhi Topley and Wilson)
- 17 Eubacterum minutum (Tissier) Prévot (Bacillus anaerobicus minutus Tissier, Recherches sur la flore intestinale des nourissons, Paris, 1900; Bacteroides minutus Hauduroy et al , Diet. d Bact Path, 1937, 64; Prévot, Ann. Inst Past., 60, 1933, 295) From intestine of breastfed utfant
- 18 Eubacterium parvum (Choukévitch) Prévot. (Coccobacillus anaerobicus parvus Choukévitch, Ann. Inst. Past., 25, 1911, 256; Prévot, Ann. Inst. Past., 60, 1938, 295) From large intestine of a horse.

19. Eubacterium Ientum, (Eggett Prévot. (Bacteroides lentus Eggett Jour. Bact., 50, 1935, 280; Prévot, An Inst. Past., 60, 1933, 295.) From hums foces.

## Genus II. Catenabacterium Prérot (Ann. Inst. Past., 60, 1938, 231)

Non-motile, straight or curved rob Usually grow in long chains or filaments No branching. Not capsulated Gram positive. Anaerobic.

- 1. Caternobacterium helminthoile. (Lawkowicz) Prévot. (Bacellus kelms thoides Lowkowicz, Arch. de Méd Exp. 18, 1901, 631; Prévot, Ann. Inst. Past. 60, 1938, 295.) From mouth of brestfed infant.
- Catenobacterium filamentosum Prévot. (Jungano, Compt. rend. Soc Biol., Paris, 60, 1909, 112 and 122; Prévot, Ann. Inst. Past., 60, 1933, 295) From intestine of a rat.
- 3. Catenabacterium lottii Prévot (Lotti, Ann. Ig. Sper., 13, 1907, 75; Prévot, Ann. Inst. Past., 60, 1933, 285) From human appendix and intestine
- 4. Catenabacterium catenaforme (Eggerth) Prévot. (Bacteroides cates) formis Eggerth, Jour. Bact., 30, 193, 286; Prévot, Ann. Inst. Past., 60, 133, 295.) From human foces.
- 5. Catenabacterium nigrum (Repai) Prévot. (Streptobacillus gangrane psinonaris Repaci, Compt. rend. Soc. Bol. Paris, 61, 1910, 110; Prévot, Ann. Ist Past., 60, 1938, 296.) Irom gangrenou tissue found in a lung.

# Genus III. Ramibacterium Privol. (Ann. Inst. Past., 60, 1938, 231)

Non-motile, straight or curved rods with frequent branching. Not caped lated. Gram-positive. Anaerobic

1. Ramibacterium ramosum (Veillos and Zuber) Prévot. (Bacillus ramosu Veillon and Zuber, Arch. méd evy et mat. path., 10, 1893, 542; Nocarla ramosa Vuillemin, Encyclopédie Moc., Paris, 2, Champignos Parastts, 1931, 132; Actinomyces ramosus Nat.

mazz, in Pollacci, Tratt Micopat Umana, 4, 1934, 42; Fusiforms ramosus Topley and Wilson, Prine Bact and Immun. 2nd ed., 1936, 338, Hauduroy et al., Diet d. Bact. Path, 1937, 71 regard Bacillus poccilodas (Eubacterium poccilodas) as a synonym; Prévot, Ann Inst. Past. 60, 1938, 296) Commonly found in approphisity.

2 Ramibactersum ramosoides (Runeberg) Prévot. (Bacillus ramosoides Runeberg, Arb a d path Inst d Univ Helsingfors, 2, 1908, 271, see Cent f Bakt, I Abt, Ref., 43, 1909, 655, Prévot, Ant, I Lat., 869, 1938, 296 Fom peritoneal flug in appendiectis

3. Ramibacterium pseudoramovum (Distaso) Prévat (Bacillus pseudoramosus Distaso, Cent f Bakt, 1 Abt, Orig, 62, 1912, 411, Bacteroides pseudoramosus Bergey et al, Mantul, 1st ed, 1923, 250; Prévot, Ann Inst Past, 60, 1933, 296) From buman feces

Genus IV. Cillobacterium Précot (Ann Inst Past . 60, 1938, 294)

Motile, straight or curved rods Peritrichous Not capsulated Gram-posi-

tive Anaerobics

1. Cillobacteriii moniliforme (Repaci) Prévot. (Bacillus moniliformis Repaci, Compt. rend. Soc. Biol. Parts, 61, 1910, 216; Prévot, Ann. Inst. Past., 60, 1938, 296.) From the respiratory system.

2. Cillobacterium endocarditis (Routier and Braunberger) Prévot (Baetlle BG, Routier and Braunberger, Comptend. Soc. Bol., Paris, 115, 1934, 611, Prévot, Ann. Inst. Part., 60, 1938, 295.)

From febrile endocarditis

3 Cillobacterium meningitis Prévot (Slamm S V., Ghón, Mucha and Muller, Cent f Bakt, I Abt, Org. 41, 1996, 145 and 693; Prévot, Ann Inst Past, 69, 1978, 237) From meningitis following chronic ottus (

4. Cillobacterium spatuliforme Prévot (see Bacillus tenuts spatuliformis Distant). Said to belong to Bacillus welchis group but no spores observed.

5 Cillobacterium multiforme Prévot (see Bacillus multiformis Distaso). Said to belong to Bacillus welchii group but no spores observed.

Genus V Bifidobacterium Orla-Jensen (Orla-Jensen, Le Lait, 4, 1924, 469; Bifidibacterium (sic) Prévot, Ann Inst Past, 69, 1938, 303.)

Non-motile rods which may be swollen. The ends may be bifurcate or double bifurcate. Grain-positive Anaerobic. This genus is regarded as one of four genera of lactic acid, rod-shaped bacteria by Orla-Jensen, and he states that the organisms in the genus form dextro rotatory lactic acid. It is placed in the Order Actinavectates by Prévot.

1 Bifidibacterium bifidum (Tissier) Prévot. (Prévot, Ann. Inst Past, 60, 1938. 303) See Laciobacillus bifidus

(Tissier) Holland.

2 Biβdibacterium appendicitis Prévot (Bacillus α Lotti, Ann Ig Sper, 19, 1909, 75, Prévot, Ann Inst. Past., 60, 1938, 303.) From an infected appendix

3 Bifidibacterium constellatum (White) Prévot (Bacillus constellatus White, Jour. Path and Bact., 24, 1921, 69; Prévot, Ann Inst. Past, 60, 1938, 303) From the missing of bees.

4 Bifdibacterium intestinalis Prévot. (Bacillus intestinalis luberculiformis Jacobsen Also uses Bacillus tuberculiformis and Bacillus tuberculiformis intestinalis, Ann Inst Past, 22, 1908, 315, Prévot, Ann Inst Past, 60, 1938, 303) From feces of an infant

5 Bifdibacterium cornulum (Distroo) Peévot. (Bacillus cornulus Distroo) Cent ! Bakt, 1 Abt, Orig, 62, 1912, 413, Bacteroules cornulus Castellani and Chalmers, Man Trop Med., 1919, 960, Prévot, Ann Inst. Past, 60, 1933, 303 ) From human mouth and intestine.

6 Bifidibacterium bifurcatum Prévot (Bacillus bifurcatus gazogenes Chouké vitch, Ann Inst. Past., 22, 1911, 318; Prévot, Ann Inst. Past., 60, 1938, 303) From intestine of a horse.

#### Genus II. Microbacterium Orla-Jensen.

(The Lactic Acid Bacteria, 1919, 179.) From Greek mikros, small and M. L. bacterium, a small rod.

Small rods. Non-motile. Gram-positive. Produce lactic acid but no gas from carbohydrates. Surface growth on media is good. Produce catalase. Usually hest-resistant. Found in dairy products and utensils, feed matter and soil.

The type species is Microbacterium lacticum Orla-Jensen.

# Key to the species of genus Microbacterium.

- I. Acid from starch; survives 85°C for 21 minutes.
- 1. Microbacterium lacticum.
- II. No acid from starch; survives 71.6°C for 2} minutes.
  - 2. Microbacterium flavum.

Microbacterium lacticum Orla-Jensen. (The Lactic Acid Bacteria, 1919, 199, Corynbacterium Lacticum Jensen, Proc. Linnean Soc of New So. Wales, 69, 1934, 50) From Latin Lac, milk; M. L., pertaining to milk.

Small thin rods. 0.3 by 1.0 micron, may have coccus-like appearance. Nonmottle. Granular. Gram-positive. Angular and pallisade arrangements of cells are characteristic

Agar slant: White or at times slight greenish-yellow growth, adherent

Gelatin: No liquefaction.

Milk: Acid, coagulation variable Nitrites usually not produced from nutrates.

Indole not formed

Acid from glucose, fructose, mannose, galactose, maltose, lactose, dextrin and starch. No acid from sylose, arabinose, rhamnose, or raffinose Dextro lactic acid formed.

Catalase is produced

Temperature relations. Minimum 10°C. Optimum 30°C. Maximum 35°C Survives 85°C for 2½ minutes in skimmik.

Aerobie to facultative anaerobic.

Source From cheese, milking equipment, grass, human and bovine feces Orla-Jensen (loc. cit., 180-181) identifies the Bacillus acidophilus cultures obtained by him from the Král collection as belonging to this species. The characters of the Král cultures deviate from the characters of Bacillus acidophilus st given by Moro

Habitat: Human and bovine intestinal tract and probably soil.

2. Microbacterium flavum Orla Jensen. (Orla Jensen, The Lactic Acid Bacteria, 1910, 181; Mycobacterium flarum Jensen, Proc. Linnean Soc. of New So. Waler, 69, 1934, 34.) Front Latin flavas,

yellow.

Rods: 0.5 by 1 to orderons. Granular and therefore some loss confused with micrococci. Non-m. e. Gram-positive Agar: Surface growth usually yellow

and viscid.

Gelatin: No liquefaction

Broth containing 10 per cent salt: Grows as flaky precipitate.

Milk: Slight neidity with no coeguls

Nitrites produced from sitrates

Indole not formed

Acid from glucose, fructose, mannose, galactose, raffinose and mannitol. No acid from xylose, arabinose, rhamnose,

Arranged by Prof. C. S. Pederson, New York State Experiment Station, General New York, June, 1938; further revision by Dr. M. L. Speck, Baltimore, Maryland, Sept., 1943.

sorbitol, inulin, starch, or salicin

Catalase is produced.

Temperature relations · Optimum 30°C.

Maximum 35°C. Minimum 20°C. Survives 71.6°C for 2½ but not 10 minutes

Aerobic to facultative anaerobic Source From milk, cheese, butter, milking equipment, bovine feces

Habitat Bovine intestinal tract and probably soil

Appendix: While Orla-Jensen has placed the following species in the genus Microbacterium, the description is incomplete and the organism differs from the other species in the genus in several important characters. Therefore it is placed in this appendix.

Microbacterium liquefacens Orla-Jensen. (Orla-Jensen, The Lactic Acid Bacteria, 1919, 182; Corynobacterium liquefaciens Jensen, Proc. Linnean Soc of New So. Wales, 59, 1934, 49) From Latin liqueo, to be liquid; facto, to make. Morphologically resembles Microbacterium lacticum.

Agar . Surface growth is faint yellowishgreen.

Gelatin: Liquefied.

Milk: Repnet coagulation in 1 to 3

weeks; the casein is peptonized gradually. Catalase is produced.

Temperature relations: Optimum 30°C, Withstands heating to 80°C.

Action on carbohydrates has not been described, Orla-Jensen states that very little acid is produced.

Source: From milk and more frequently from cheese.

Habitat Presumably dairy products.

Norn The following species may belong here: Bacterium coscolyticum Kitahara, Jour Agr. Chem See Japon, Tokyo, 14, 1938, 121 and 1461. A Grampositive, acid-forming and proteolytic rod said by the author to be related to Microbotterium liquefactens

### Genus III. Propionibacterium Orla-Jensen \*

(Cent. f. Bakt., II Abt., 22, 1909, 337.) From M. L., propionic, and bacterium, a

Non-motile. Non-spore-forming. Gram-positive bacteria growing under anserbice conditions in neutral media as short diphtheroid rods, sometimes resembling streptococci; under aerobic conditions with heavy inoculum growing as long, irregular, club-shaped and branched cells. Metachromatic granules demonstrable with Albert's stain. Ferment lactic acid, carbohydrates, and polyalcohols with the formation of propionic and acetic acids and carbon dioxide. As a rule strongly calabse positive, sometimes weakly so. Strong tendency towards anserobiosis; development very slow, macroscopically visible colonies generally not discernible in less than 5 to 7 days.† Nutritional requirements complex. Development best in yeast evined media with addition of lactates or simple carbohydrates. Optimum temperatur 30°C. Found in dairy products, especially hard cheeses.

The type species is Propionibacterium freudenreichii van Niel.

### Key to the species of genus Propionibacterium.

- I In yeast extract-glucose media growth occurs in the form of small streptococt-Dirty cream-colored growth in stabs, with slight surface growth of same color. Sucrose and medicae not fermented.
  - A Not fermenting lactose.
- 1. Propionibacterium freudenreichii.
- B. Fermenting lactose.
- 2. Propionibacterium shermanii.
   II In yeast extract-glucose media growth occurs in the form of typical short rods of diphtheroid appearance. Distinct surface growth in stabs. Sucrose and maltose are fermented.
  - A. Growth brownish-red.
    - 1. Ferments raffinose and mannitol, but not sorbitol.
      - 3. Propionibacterium rubrum.
    - 2. Ferments sorbitol, but not raffinose and mannitol.
      - 4. Propionibacterium thoenii.
  - B. Growth in stab cream-colored.
    - Surface growth cream-colored.
       Ferments l-arabinose and rhamnose.
      - 5. Propionibacterium zeac.
    - 2. Surface growth yellow to orange.
      - a. Growth in liquid media flocculent, as if agglutinated.
        - 6. Propionibaclerium peterssonii.
      - aa. Growth in liquid media dispersed, smooth.

Revised by Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, Chloronia, June, 1938; further revision by Prof. Van Niel, January, 1944.

† In an atmosphere containing 5 per cent carbon diovide, growth is enhanced both aerobically and anaerobically. Contrary to the claim made by Krebs and Egglesion (Biochem Jour, 35, 1941, 676) a differential effect of carbon diovide tension on aerobic and anaerobic development has never been observed.

b. Do not ferment dextrin, glycogen or starch.

7. Propionibacterium ienzenii. 8. Propionibacterium rafinosaceum.

bb. Ferments dextrin, glycogen and starch.

9. Propionibacterium technicum.

III In yeast extract-glucose media growth occurs in the form of highly irregular cells, giving the appearance of involution forms. Distinct surface growth in stabs. Both d- and l- arabinose are fermented.

A. Involution forms large, swollen spheres. Surface growth orange-yellow. Does not ferment xy lose and rhamnose.

10. Propionibacterium grabinosum.

B. Involution forms long, irregular rods. Surface growth eream-colored. Ferments xylose and rhamnose.

11. Propionibacterium pentosaceum.

1 Propionibacterium freudenreichii van Niel. Bacterium acidi propionici a. von Freudenreich and Orla-Jensen, Cent f. Bakt., II Abt , 17, 1906, 532; Bacterium neidi propionici var. fuecura Thoni and Allemann, Cent. f Bakt . II Abt., 25, 1910, 29; van Niel, The Propionic Acid Bacteria, Haarlem, 1928, 162, Werkman and Brown, Jour. Bact., 25, 1933, 397.) Named for Educard von Freudenreich, the Saiss bacteriologist, who isolated this species

Description taken from van Niel, and

Werkman and Brown

Small apherical cells, 0.5 to 0 6 micron, metty in mire and short chains Little difference in morphology between growth from anserobic solid media and neutral or said liquid media. Aerobic growth irregular, club-shaped and branched, lorg rode. Non-motile. Show metacharatic granules. Gran poittee

Yout gelatin betate stab; No liquefaction.

Yeart ager betate stabe Duty grayishcreamy dearl amount in stab; very shight suffere growth of same color.

Light reductionally turied with

granuli errarit, pay sediment Late on roll, blight dead greent, fairt referting Not engalited

Catalan tention Ind de to I f at my

National test amount of from autostes bermares better and popular ands. glycend, dlydn systet co.glumes, fractose, mannore and galactore with the formation chiefly of propionic and acetic acids, and eathon dioxide.

Acid from crythritol, adonitol, inositol and esculin. No acid from amyrdalin. d-and f-arabinose, dextrin, dulcitol, glycogen, inulin, lactore, maltone, mannitol, meleritore, melibiore, perseital, raffinore, thampee, sucree or xylose. Anserobie.

Distinctive characters: Inability to ferment any of the descelarides when inoculated in yeast extract-sugar media.

Source From dairy products; raw market milk, Suiss cheese.

Habitat · Dairy products.

2. Propionibacterium shermanii van Niel (Racterium acidi propionici d. Sherman, Jour. Bact . 6, 1921, 387; van Niel, The Propionic Acul Barteria, Haarlem, 193, 163; Werkman and Brown, Jur. Bart., 25, 1921, 400 ) Named for J. M. Sherman, the American Insteriolreset, who induted this species

Description taken from van Niel, and Werkman and Brown.

F-all of bened celle, 0.5 to 0.6 mirne. restly in mire and start chains Little difference in existed at letteren smath from anaember witch media and present er will book mode. Applie growth stregular, elabelaped and texpeled refe Sentratile this retarbon cate canda Gammatter.

Probably from silage.

Habitat: Dairy products.

6. Propionibacterium peterssonii van Niel. (Bacterium acidi propionici c, Troili-Petersson, Cent. f. Bakt., II Abt., 24, 1909, 333; van Niel, The Propionic Acid Bacteria, 1923, 163; Werkman and Brown, Jour. Bact., 26, 1933, 406.) Named for Gerda Troili-Petersson, the Swedish bacteriologist, who isolated this organism.

Description taken from van Niel, and Werkman and Brown.

Cells in neutral media spherical, 0.8 micron, occurring as short streptococci in clumps In carbohydrate media which turn acid during development, rod-shaped cells in clumps, 0.8 by 1.5 to 2.0 microns. Aerobic growth, heavily swollen and branched rods. Non-motile. Show metachromatic granules. Gram-positive.

Yeast gelatin-lactate stab No liquefaction

Yeast agar-lactate stab: Cream-colored growth, dry and wrinkled, resembling that of Mycobacterium spp.

Liquid media: No turbidity, sediment a coherent layer, cream-colored

Litmus milk: Acid, congulated.

Catalase positive; aerobically developed growth very slightly so.

Indole not formed.

Nitrites not produced from nitrates. Ferments lactic and pyruvic acids, glycerol, dhydroxyacetone, glucose, fructose, mannose, galactose, sucrose, maltose and lactose with the formation of propionic and acetic acids, and carbon dioxide

Acid from esculin and saliem. No acid from d- and 1 arabinose, cellobiose, devtrin, dulcitol, glycogen, inulin, perseitol, pectin, raffinose, rhamnose, sorbitol, starch or xylose.

Less anaerobic than Propionibacterium freudenreichii and Propionibacterium shermanii.

Distinctive character Growth in liquid media in clumps, giving the cul-

tures the appearance of agglutinated bacteria. So far, the only species among the propionic acid bacteria possessing this characteristic.

Source: From cheese and soil. Habitat · Dairy products.

7. Propionibacterium jensenii van Niel. (Bacterium acidi propionici b, von Freudenreich and Orla-Jensen, Ceat f. Bakt., II Abt., 17, 1906, 532; van Niel, The Propionie Acid Bacteria, 1928, 183; Werkman and Brown, Jour. Bact, 86; 1933, 404.) Named for Prof. S. Orla-Jensen, the Danish bacteriologist, who isolated this organism.

Description taken from van Niel, and Werkman and Brown

In neutral media spherical to short rod-shaped cells, often in pairs or short chains, 0.8 by 0.8 to 15 microns, of typical diphtheroid appearance. Morphology little influenced by developing acidity. Aerobic growth, irregular long rods, swollen and branched. Non-motile Metachromatic granules. Gram-positive.

Yeast gelatin-lactate stab: No liquefaction.

Yeast agar-lactate stab: Cream-colored growth in stab, orange-yellow, domeshaped surface growth.

Liquid media: Turbid in early stages; cream-colored, smooth sediment.

Litmus milk: Congulated, acid. Catalase. Strongly positive.

Indole not formed.

Nitrites not produced from nitrates Ferments lactic and pyrtwic acts, glycerol, dihydroxyacetone, glucose, fuctose, mannose, galactose, sucrose, maliose, lactose and sometimes rafinese and mannitol with the formation of proposit and acetic acids, and carbon dioxide

Acid from adonatol, arabitol, erythritol, esculin, inositol and trehalose. No acid from arabinose, cellobiose, dettrin, duletol, glycogen, inulin, perseitol, pecun, rhamnose, salicin, sorbitol, starch or vylose.

Less anaerobic than Propionibacterium freudenreichii

Distinctive characters Morphologically similar to Propionibacterium rubrium and Propionibacterium themis from which it is chiefly distinguished by the failure to produce a red pigment under anaerobic conditions. The yellow surface growth distinguishes Propionibacterium zensens from Propionibacterium zensens from Propionibacterium zensens as also the inability of the former to ferment l-arabinose and rhamnose.

Source · From cheese and butter. Habitat: Dairy products

8 Propionibacterium raffinosaceum Werkman and Kendall. (Propionibacterium jensemi var raffinosaceum van Niel, The Propionic Acid Bacteris, 1928, 162, Werkman and Kendall, Jowa State Coll Jour. Sci., 6, 1931, 17; Werkman and Brown, Jour Bact, 26, 1933, 402 From M. L. raffinosum, the sugar raffinose.

Description taken from van Niel, and Werkman and Brown

Cells in neutral media spherical to short rod-shaped cells, 0 8 by 0 8 to 15 microns, of typical diphtheroid appearance In media in which acid is produced the cells are somewhat longer rodshaped, to 2 microns in length Aerobic growth irregulart, long rods, swollen and brunched Non-motile Metachromatic granules Gram-mositive.

Yeast gelatin-lactate-stab. No lique-

Yeast agar-lactate-stab Cream-colored growth in stab; distinct, orange-yellow surface growth

Liquid media. Turbid in early stages, cream-colored, smooth sediment

Litmus milk, Congulated, acid Catalase positive; aerobically grown

only very slightly so Indole not formed.

Nitrites not produced from nitrates Ferments lactic and pyruvic acids, glycerol, dihydrovyacetone, glucose, fructose, mannose, galactose, cellobiose, maltose, lactose, sucrose, raffinose and mannitol with the production of propionic and

Acid from adonitol, amygdalin, arabitol, crythritol, seculin, inositol, meleritose, salicin and trehalose. No scid from d- and l-arabinose, devtrin, dulcitol, glycogen, nulin, melibiose, perseitol, pectin, rhamnose, sorbitol, starch or vylose.

Less anaerobic than Propionibacterium freudenreichis.

Distinctive characters: Differs from Proposibacterium jensenii in its some-what greater length and the ability to ferment cellobiose and salicin; the behaviour of Proposibacterium jensenii towards raffinose and mannitol is not constant, and hence cannot be used as a differential character Werkman and Kendall have reported different agglutination reactions for Proposibacterium jensenii and Propionibacterium raffinosoccium.

Source From buttermilk. Habitat: Darry products.

9 Propionibacterium technicum van Niel (Yan Niel, The Propione Acid Bacteria, 1928, 164, Werkman and Brown, Jour Bact, 26, 1933, 401) From Greek technicus, technical, M. L., of industrial significance

Description taken from van Niel

In neutral media spherical cells, 08 maron, in pairs and short chains In acid media short rods, 06 by 10 to 15 merons, often in pairs, with typical diphtheroid appearance. Aerobic growth in the form of irregular long rods, swollen and branched. Non-motile Metachromatic granules. Gram-positive.

Yeast gelatin-lactate-stab: No liquefaction.

Yeast agar-lactate-stab: Cream-colored development in stab, with distinct yellow surface growth.

Liquid media. Turbid in early stages, cream-colored, somewhat flocculent sediment. Litmus milk: Coagulation, acid. Catalase positive.

Indole not formed.

Nitrites not produced from nitrates. Ferments lactic and pyruvic acids, glycerol, dihydroxyacetone, arabinose,

glycerol, dihydroxyacetone, arabinose, glucose, galactose, fructose, mannose, actset, alactose, mallose, sucrose, raffinose, dextrin, glycogen and starch with the formation of propionic and acetic acids, and carbon dioxide

Acid from esculin salicin and mannitol. No acid from dulcitol, inulin or xylose. Anaerobic, but less so than *Propionibacterium freudenreichii*.

Distinctive characters: The ability to ferment the polysaccharides dextrin, glycogen and starch.

Source: From Edam and Tilsit cheese. Habitat Dairy products

10. Propionibacterium arabinosum Hitchner. (Hitchner, Jour. Bact, 28, 1932, 40; 28, 1934, 473; Werkman and Brown, Jour Bact, 26, 1933, 410.) From M. L. arabicum, gum Arabic; M. L. arabinosum, arabinose.

Description of culture isolated by Hitchner.

Cells in neutral lactate media spherical, 0.8 micron, in pairs and short chains. In acid media swollen spheres and ellipsoidal cells occur, mostly 2.0 by 3.0 to 3.5 microns, often in pairs and short chains. Non-motile. Metachromatic granules Gram-positive.

granules Gram-positive.
Yeast gelatin-lactate-stab: No lique-

Yeast agar-lactate-stab: Cream-colored growth in stab, with distinct orangeyellow surface growth.

Liquid cultures: Turbid in early stages, cream-colored, smooth sediment.

Litmus milk: No coagulation. Catalase very slightly positive.

Indole not formed.

Nitrite production not recorded.

Ferments lactic and pyruvic acids, glycerol, dihydroxyacetone, d- and l-arabinose, glucose, galactose, fructose, mannose, cellobiose, maltose, sucrose,

raffinose and mannitol with the production of propionic and acetic acids, and carbon dioxide.

Acid from sorbitol. No acid from dulcitol, xylose, rhamnose, salicin or inulin.

Anserobic, but less so than Propionibacterium freudenreichii.

Distinctive characters: The development of spherical involution forms in acid media, the almost complete absence of catalase, the ability to ferment both d- and l-ambinose, but not xylose and rhamnose.

Source: Not definitely stated.

Habitat: Dairy products.

Note: The strain obtained from Dr. E. B. Fred produced only minute amounts of acid from lactose and starch. It is questionable whether these carbohydrates are formented.

11. Propionibacterium pentesseem van Neil. (Bacillus acidi propionic von Freudenreich and Orla-Jensen, Cent. f. Bakt., II Abt., 17, 1906, 532; van Nel, The Propionic Acid Bacteria, 1928, 163; Werkman and Brown, Jour. Bact., 25, 1933, 408.) From M. L. pentosum, 2 pentosum, 2

Description taken from van Niel, and Werkman and Brown

Werkman and Brown.

In neutral lactate media cells spherical,
0.8 micron, in pairs and short chairs.

In media developing acidity long, irregular rods, swollen and branched, to 3 to 4 microns in length. Aerobic growth irregular, swollen and branched, long rods.

Non-motile. Metachromatic granules.

Gram positive.

Yeast gelatin-lactate stab: No liquefaction. Yeast agar-lactate stab: Cream-colored

Yeast agar-lactate stab occamdevelopment in stab, with abundant, cream-colored surface growth.

Liquid media: Turbid in early stages; smooth, creamy sediment, ropy.

Litmus milk: Coagulated, acid. Catalase: Slightly positive.

Indole not formed.

Nitrites and free nitrogen produced from nitrates.

Ferments lactic and pyruvic acids, glycerol, dhydrovyacetone, d- and l-srabinose, xylose, rhamnose, glucose, glucose, ctose, fructose, mannose, cellobiose, lactose, maltose, sucrose, raffinose, mannitol and sorbitol with the formation of propionic and acotic acids, and carbon dioxide.

Acid from adoúitol, arabitol, erythritol, esculin, inositol, saliein and trehalose No acid from dextrin, duleitol, glycogen, inulin, perseitol or pectin.

Anaerobic, but less so than any of the other species of the genus

Distinctive characters: The formation of long, rod-shaped involution forms in acid media; the absence of pigment production, and the ability to ferment dand l-arabinose, rhamnose and xylose

Source · From Emmental cheese Habitat: Dairy products.

Appendix: Cultures of the following species have not been available for study It is probable that these duplicate pre viously described species

Propionibacterium amuloaceum var. au-

ranticum Sakaguchi, Swasaki and Yamada. (Bull. Agric Chem. Soc. Japan, 17, 1941, 13.) From cheese. Resembles Propionibacterium peniosaceum closely.

Propionibacterium coloratum Sakaguchi et al. (loc. cit.). From cheese. Resembles Propionibacterium thoenii.

Prepionibacterium globosum Sakaguchi et al. (loc. cil.). From cheese. Resembles Propionibacterium shermanii. Said not to ferment glycerol and ery-

thritol.

Propionibacterium japonicum Sakaguchi et al (loc. cit.). From cheese.

Said not to ferment glycerol and erythritol.

Propionibacterium orientum Sakaguchi

et al. (loc cit.). From cheese. Ferments l-arabinose. Resembles Propionibacterium shermanii.

Janoschek (Cent. f. Bakt., II Abt., 106, 1944, 521) has suggested a key for the identification of the species in this genus. This is based on chromogenesis and cultural characters If recognizes three additional species: Propionibacterium existing and Propionibacterium patitiosum and Propionibacterium sanguineum.

### Genus IV. Butyribacterium Barker and Haas.\*

(Jour. Bact., 47, 1944, 301.) From the chemical term, butyric and M. I. bacterium, a small rod.

Non-motile, anaerobic to microaerophilic, straight or slightly bent rods. Granpositive. Ferment carbohydrates and lactic acid forming acetic and butyric acids, and carbon dioxide. Generally catalase negative but sometimes weakly positive Intestinal parasites.

The type species is Butyribacterium rettgeri Barker and Haas.

 Butyribacterium rettgerl Barkerand Haas. (Strain 32, Lewis and Rettger, Jour. Bact., 40, 1940, 298; Barker and Haas, Jour. Bact., 47, 1944, 303.) Named for L. F. Rettger, The American bacteriologist.

Rods: Straight or slightly bent, noncapsulated. 0.7 by 2 3 microns. Occur singly, in pairs and short chains. No branched cells observed but some cells have swollen club-shaped ends. Nonmotile. Gram-positive.

Glucose-cysteine agar: Colonies circular, entire or finely irregular margin, translucent, often with opaque center, grayish-white with yellowish tinge, convex when small, later unbonate, glistening, smooth, finely granular. Develop slowly attaining a diameter of 1.5 mm in 7 days.

Tryptone-yeast extract-lactate agar: Colonies similar to above except larger (2 mm in 4 days at 37°C). Pulvinate rather than umbonate in cross sections.

Glucose-cysteine-broth: Abundant turbidity and sediment No pellicle.

Agar stab (King and Rettger's medium, Jour. Bact., 44, 1942, 302): Heavy growth in 2 days. Gas production often causes slight splitting of agar.

Acetic and butyric acid and CO2 pro-

duced from glucose and maltose. Occasionally a small amount of visible gas is produced. Lactic acid fermented readily without visible gas. Arabinose, xylose, lactose, sucrose, trehalose, rhamnose, mannitol, sorbitol, dulcitol and glycerol are not fermented.

Not proteolytic.

Indole and hydrogen sulfide not formed.
Temperature relations: Optimum 37°C.
Maximum 40 to 45°C. Minimum 15°C
Generally catalase negative.

Anaerobic. Source: From intestinal contents of a

white rat.

Habitat: Presumably found generally in the intestine of mammals.

Notes: Pederson (Jour. Bact., 50, 1915, 478) has found that cultures of two species described by Eggerth (Jour. Bact., 50, 1935, 289 and 290) product higher fatty (presumably butyric) acids and lactic acid from glwcosc. These are named Bacteroides avudus and B. limesur by Eggerth. Probably these species belong in the genus Butyribacterium.

Bacillus cadareris bulyricus Budst (Cent. f. Bakt., I Abt., 24, 1898, 374) may also belong in this genus.

<sup>\*</sup>Prepared by Prof. C. S. Pederson, New York State Experiment Station, Geneva, New York, January, 1945; reviewed by Dr. H. A. Barker, Berkeley, California.

#### FAMILY VIII. CORYNEBACTERIACEAE LEHMANN AND NEUMANN,

(Bakt Diag., 4 Aufl., 2, 1907, 500.)

Non-motile (motile in Listeria) rods, frequently banded or beaded with metachromatic granules. May show marked diversity of form. Branching cells have been observed in a few species but these are uncommon. Generally Gram-positive but this reaction may vary depending on the nature of the cells. Where pigment is formed, it is grayish-yellou to otange or pink in color. Aerobic to microacrophille. Anaerobic species have been reported. Gelatin may be liquefied and nitrites may be produced from nitrates. Animal and plant parasites and pathogens. Also from dairy products, soil and water.

#### Key to the genera of family Corynebacteriaceae.

I Aerobic to microaerophilic, non-motile (or questionably motile) rods which are variable in form Animal and plant parasites and pathogens, with some from dairy products, soil and water.

Genus I. Corynebacterium, p 381.

II. Small aerobic rods with 1 to 4 flagella. Causes a monocytosis in warm-blooded animals.

Genus II Listeria, p 408

III. Microaerophilie, non-motile rods to long filaments Pathogenic on warm-blooded animals.

Genus III. Erysipelothrix, p 410.

# Genus I. Corynebacterium Lehmann and Neumann.\*

(Lehmann and Neumann, Bakt Diag, 1 Aufi, 2, 1896, 300, Corynethrix Czaplewski. Deutsche med Welmschr., 26, 1900, 723, Corynemonas Orla-Jensen, Cent f. Bakt., II Abt., 22, 1900, 314, Corynobacterium Enderlein, Sitzber Gesell, Naturf. Freunde, Berlin, 1917, 309, Plecamobacterium Lowi, Wiener klin Wchnschr., 53, 1920, 730. From Greek Koryne, cibb and M L. bacterium, a small rod.

Slender, straight to slightly curved rods, with irregularly stained segments or granules. Frequently show pointed or club-shaped swellings at the ends Snapping division produces angular and palisade (picket fence) arrangements of cells Non-motile with possible exceptions as stated in the text. Gram-positive to variable, sometimes young cells and sometimes old cells being Gram-negative Granules invariably Gram-positive. Generally quite aerobic, but microscrophilic or even anaerobic species occur. Catalase positive They may or may not liquefy gelatin, and may or may not produce intrites from nitrates. They may or may not ferment sugars, but they seldom produce a high acidity. Many species ordine glucose completely to CO<sub>2</sub> and Hi<sub>2</sub>O without producing visible gas. Some pathogenic species produce a powerful evotovin. This group is widely distributed in nature. The best known species are parasites and pathogens on man and domestic animals. Other species have been found in birds and insects and the group is probably more widely distributed in the animal kingdom than thas. Several species are well known plant pathogens while still other common species are found in dury products, water and soil

The type species is Corynebacterium diphtheriae (Flügge) Lehmann and Neumann.

Restranged by Prof E. G. D. Murray, McGill University, Montreal, P. Q. Chanda and Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1918, completely revised by Prof. E. G. D. Murray, Montreal, Prof. Robert S. Breed, Geneva and Prof. Walter H. Burkholder, New York State College of Agriculture, Hheas, New York, February, 196.

## Key to the species of genus Corynebacterium.

- I. From human sources.\* Non-motile.†
  - A. Aerobic. No liquefaction of gelatin.
    - 1. Acid from glucose and usually maltose and galactose. Usually no acid from sucrose. Causes diphtheria.
      - 1. Corvnebacterium diphtheriae.

- 2. Not as in 1.
  - a. No acid from carbohydrates.
  - 2. Corynebacterium pseudodiphtheriticum.
  - aa. Acid from glucose and sucrose.
    - b. Highly pleomorphic, varying from cocci to rods.
      - 3. Corynebacterium enzymicum. bb. Rods with polar staining with club forms, diphtheroidinappearance.
        - 4. Corunebacterium xerose.
    - bbb. Rods as above but characteristic salmon pink growth on coagulated blood serum.
- 5. Corunebacterium hoagii.
- B. Microaerophilic to anacrobic. Growth feeble or none at all on gelatin. 6. Corunebacterium acnes.
- · II. From domestic and laboratory animals. Non-motile.
- A. Acid from glucose.
  - 1. Grows poorly if at all on ordinary gelatin and agar. Slow liquefaction of serum gelatin and congulated blood serum. Causes suppurative processes in cattle, swine, and other animals.
    - 7. Corynebacterium pyogenes.
  - 2. No liquefaction of gelatin or blood serum. Grows poorly, if at all, on ordinary gelatin and agar.
    - a. Cause of pyelonephritis in cattle.
    - 8. Corunebacterium renale.
    - aa. Found in caseous nodules resembling those of tuberculosis. Found in sheep, horses and some other animals.
      - 9. Corynebacterium pseudotuberculosis.
    - asa. From caseous nodules in mice.
      - 10. Corynebacterium kutscheri.
    - aaaa. Causes a septicemia in mice.
  - 11. Corynebacterium murisepticum.
  - B. No acid from carbohydrates. No liquefaction of gelatin. 1. From milk and bovine udder.
    - 12. Corynebacterium bovis.

\* Habitat relationships are used because comparative studies of the species in the genus are still completely lacking.

The reports of motile species in this genus present a puzzling problem, particularly larly as the motile species of plant pathogens placed in the genus are polar fisgellate. Some students of the group feel that, if motile species really evist, they should be placed in a separate genus. Others feel that a more careful study of the described polar flagellate species will show that these species really belong elsewhere. Where authors have reported motility, this fact is indicated in the text. It should be noted that similar uncertainties exist in regard to described cases of motility among the streptococci and lactobacilli.

- 2. From pneumonia in foals.
- III. From insects. Non-motile.
  - A. No acid from carbohydrates. Slow liquefaction of relatin.
  - 14. Corynebacterium paurometabolum.
- IV. Plant nathogens. Non-motile.
  - A. Nitrites not produced from nitrates
    - 1. Colonies cream-colored. Slow liquefaction of gelatin.
      - a Bluish granules in growth. Attacks alfalfa.
      - 15. Corunebacterium insidiosum.
      - aa. No bluish granules Causes ring rot of potatoes.
    - 2. Colonies vellow
    - Colonies yellow
       No liquefaction of relatin Causes a wilt and canker of tomatoes.
    - 17. Corynebacterium michiganense.
  - B. Nitrites produced from nitrates. Slow or no liquefaction of gelatin.

    1. Colonies vallow Attack members of the grass family
    - members of the grass family.

      18. Corumehacterium rathavi.

13. Corunebacterium equi.

- 19 Corynebacterium rainayi.
- 2. Colonies orange Parasitic on sweet peas, etc.
- V. From soil and water slow (7 weeks).
  - A. Acid from plucose Non-motile.
    - I. Nitrites not produced from nitrates
      - 21. Corynebacterium helvolum.
    - 2. Nitrites produced from nitrates
      - a. Cellulose digested.
      - aa. Cellulose not digested.
    - 23 Corynebacterium tumescens.
  - B. No said from glucose. Some indication of motility in No 25.
    - 1. Cells coccoid to short, straight or curved rods
    - Young cells curved rods in parallel bundles These may grow out into filaments with branching.
      - 25 Corynebacterium filamentosum.

1. Corynebacterium diphtheriae (Flüsge) Lehmann and Neumann (Microspron diphthericum Kleb (protocype), Verhandl. d. Congr. f. innere Med. 2, 1883, 143; die Klebs'schen Eithelten, Löffer, Mitteil. a. d. kaiserl Gesundheitsamte, 1831; Bacıllus diphtheriae Flügge, Die Mikmorganismen, 2 Aufl., 1885, 223; Pacuna looffert Trevivan, I generie la specie delle Batteriacce, 1889, 23; Lehmann and Neumann, Bakt. blage, 1 Aufl., 2, 1893, 390

Bacterium diphtheriae Migula, Syst. d. Bakt., 2, 1900, 499.) From Greek diphthera, a piece of leather; M. L., the disease diphtheria.

Common name Diphtheria bacillus; Klebs-Locffer bacillus.

Rods, varying greatly in dimensions, 0.3 to 0.8 by 1.0 to 8.0 microns, occurring singly. The rods are straight or slightly curved, frequently swollen at one or both ends. The rods to not, as a rule, stain uniformly with methylene blue but

show alternate bands of stained and unstained material and in addition one or more metachromatic granules which are best shown by special stains. Non-motile. Gram-positive but not intensely so in older cultures.

Gelatin colonies: Slow development. Very small, gravish, lobulate.

Gelatin stab · Slight growth on surface and scant growth in stab. No liquefaction.

Agar slant: Scant, grayish, granular, translucent growth, with irregular margin.

Blood-tellurite media: Produces gray to black colonies.

Colony forms: Smooth (S) colony form: Round and umbonate or convex, with even margin and smooth surface. Opaque when viewed by transmitted light, glistening and somewhat moist in appearance when viewed by reflected light Colonies about 1 to 3 mm in diameter. Growth frequently slowed or inhibited by the presence of potassium tellurite in the medium.

Rough (R) colony form Flat, margin is very irregular. Surface is pitted and very uneven. Very little light reflected from surface Translucent when viewed by transmitted light. Colonies about 1 to 5 mm in diameter.

Intermediate colony forms: Several colony forms are found in this group since the term includes all forms between the pure S form and the pure R form. Sr forms very nearly approach the S colonies and the RI forms nearly approach the pure R forms. The SR form shows properties distinct from either the S or R forms. The colonies are 3 to 5 mm in diameter. The margin usually shows indentations. The surface is raised but not convex; it may be nearly level or show a central elevation surrounded by a concentric depression and elevation.

Dwarf (D) colony form: Colonies very small, about 0 2 mm or less in diameter. Margin round and even. Surface convex.

All of the above colony forms have been

isolated from cases of diphtheria (Morton, Jour. Bact., 40, 1940, 768 ff.).

Broth: Uniform turbidity produced by S form, pellicle produced by SR form, sediment produced by the R form Litmus milk: Unchanged.

Potato: No visible growth.

Blood serum: Growth grayish to creancolored, moist, smooth, slightly raised, margin entire. May be bright yellow or occasionally reddish (Hill, Sci., 17, 193, 375).

Indole is not formed.

Nitrites are produced from nitrates.

All strains form acid from glucose and fructose; some strains also ferment galatose, maltose, sucrose, dextrin and glycerol.

Does not hydrolyze urea (Merkel, Cent. f. Bakt., I Abt., Orig., 147, 1941,

A highly poisonous exotoxin is produced in fluid media. This torin represents the principal disease-producing agency of the organism. Toxin production may fail in otherwise typical strains.

A highly potent antitovin can be produced by repeated injection of toxin indexperimental animals. The antitous possesses both curative and protective properties.

Scrological types: In a study of 20 strains of Corynebacterium diphthret Murray (Jour. Path. and Bact., 41, 1935) 439-45) was able to classify 228 strains into 11 serological types and 22 strains remained unclassified (Morton, Bac Rev., 4, 1940, 196).

McLeod et al. (Jour. Path. and Bast, 34, 1931, 667; bid., 98, 1933, 169; Janet, I, 1933, 293) describe three types with have been confirmed by other worker, these are distinguishable by colony form of McLeod's blood-tellurite medium, they are antigenically different with subtypes, there is some difference better toyins (Etris, Jour. Inf. Dis., 58, 1934, 220) and the severity of disease is associated with the type.

associated with the type.

Corynebacterium diphtheriae type graus

grows with dark gray, daisy-head colonies; ferments devtrin, starch and glyco gen; is not hemolytic, has very few small metachromatic granules; forms a pellucle, granular deposit and there is an early reversal of M in heath

Corynebacterium diphtheriae type mitis grows in convex, black, shiny, entire colonies, no fermentation of starch and glycogen and is variable with destrin, hemolytic; metachromatic granules are prominent; diffuse turbuity, infrequent pellicle and there is a late reversal of pH in broth.

Corpusbacterium diphtheriae type intermedius grows a small, flat, umbonate colony with a black center and slightly crenated periphery; not hemolytic, bar ring of hacill is accentuated, there is no fermentation of starch and glycogen, and is variable with dettrin, forms no pellicle, a fine granular deposit and there is no reversal of pli in broth.

Ten years of observations in all parts of the world have shown (McLeod, Bact Rev, 7, 1913, 1) that a small percentage of strains does not correspond closely to any of these three types Variant strains are found most frequently in regions where the diphtheria is of mild or moder ate severity.

Acrobic, facultative

Optimum temperature 34° to 36°C Grows well at 37°C.

Source: Commonly from membranes in the plarynx, larynx, trachea and nose in human diphtheria; from the seemingly healthy pharynx and nose in carners, occasionally from the conjunctiva and infected superficial wounds Found occasionally infecting the nasal passeges and wounds in horses. Has been desertibed from natural diseases in foul.

Habitat. The cause of diphtheria in man. Pathogenic to guinea pigs, latters and rabbits. For action on other animals see Andrews et al., Diphtheria. London, 1923, 170 ff.

2. Corynebacterium pseudodiphtherit-

teum Lahmann and Naumann. (Racillus der nseudodinhtherie Loeffler Cont f Bakt . 2. 1887. 105 G von Hofmann Wellenhof, Wien, med Wochenschr. 48 1888 65: Lehmann and Neumann Bakt Diag , I Aufl., 2, 1896, 361, Bacillus vseudodiphthericus Kruse, in Flüere. Die Mikroorganismen, 3 Aufl. 2, 1896. Bacterium pseudodiphtheriticum Svst. d. Bakt. 2 1900 Mionla 503: Mucabacterium necudadinhthericum Chester, Man. Determ Bact., 1901, 355, Bacillus hoffmants (sic) Holland, Jour. Bact . 5. 1920, 218: Corunchacterium hoffmanss (sic) Holland, thid., 220; Corunebacterium pseudodinhtheriae Holland, thid . Coruncbacterium nseudodinh. thericum Bergey et al . Manual, 2nd cd 1925. 393 ) From Greek pseudus, a falsebood: M. L. the disease diphtheria

Common name: Pseudodiphtheria ba-

cillus or Hofmann's bacillus.

Excellent historical discussions of this and related organisms are given by Bergey, Comparative Studies upon the Pseudo-diphthera or Hofmann's Bacillus, the Kerosis Bacillus, and the Loeffler Bacillus Contrib from Lab of Hyg, Univ of Penn., No. 2, 1898, 19-54 and by Andrewes et al, Diphtheria London, 1923, 382-388

Rods, with rounded ends, 0 3 to 0 5 by 0 8 to 1 5 microns, fairly uniform in size, without smollen ends. Not barred but even staining interrupted by transverse, medral unstained septum; granules usually absent. Non-motife. Grampositive

Gelatin colonies Small, grayish to cream-colored, smooth, homogeneous, entire.

Gelatin stab Slight surface growth with little growth in stab No liquefac-

Agar colonies: Opaque, grayish to eream-colored, smooth, homogeneous, entire

Agar slant Moist, smooth, white to cream-colored, entire growth

Locffler's blood serum As on agar.

Broth: Slightly turbid with slight. gravish sediment.

Litmus milk: Unchanged.

Potato: Slight, creamy-white, smooth. entire growth.

Indole not formed.

Nitrites produced from nitrates. No acid from carbohydrate media.

Hydrolyzes urea (Merkel, Cent. f. Bakt., I Abt., Orig., 147, 1941, 398).

Aerobic, facultative.

Optimum temperature 37°C.

Not pathogenic.

Source: From oral cavity of 26 out of 45 control cases.

Habitat: Normal throats.

 Corynebacterium enzymicum (Mellon) Eberson. (An unusual diphtheroid bacillus, Mellon, Med, Record, New York, 81, 1916, 210; Bacillus enzymicus Mellon, Jour Bact., 2, 1917, 297; Eberson, Jour. Inf. Dis., 23, 1918, 29.) From Greek en, inside of ; zyme, leaven; of an enzyme.

Rods, beaded and club-shaped, definitely pleomorphic, showing coccoid forms. Non-motile. Gram-positive.

Gelatin stab Slight surface growth. No liquefaction.

Glucose agar: Bacillary form shows very small colorless colonies. Coccoid form shows heavy, vellowish-white, moist growths.

Blood agar: Same as on glucose agar. Loeffler's blood scrum: Fine, moist,

confluent growth.

Glucose broth: Bacillary form shows granular sediment Coccoid form shows diffuse, luxuriant growth.

Litmus milk: Acid, coagulated.

Potato: No growth

Indole formation slight.

Slight production of nitrites from nitrates.

Acid from glucose, maltose, sucrose, dextrin and glycerol.

Aerobic, facultative.

Optimum temperature 37°C.

Pathogenic for rabbits, guinea pigs and mice.

Source: Lungs, blood and inints Habitat: From human sources so far as known.

4. Corvnebacterium zerose (Neisser and Kuschbert) Lehmann and Neumann. (Bacillus zerosis Neisser and Kuschbert. Breslauer ärtzl. Ztschr., No. 4. Kuschbert, Xerosebacillen. Deutsche med. Wochnschr., 10, 1884, 321 and 341: Pacinia neisseri Trevissa. I generi e le specie delle Batteriacee, 1889, 23, Lehmann and Neumann, Bakt Diag., 2 Aufl., 2, 1899, 405; Bacterium zerosis Migula, Syst. d. Bakt., 2, 1900, 485.) From Greek zerus, dry.

An excellent historical discussion of this organism is given by Andrewes et al, Diphtheria, London, 1923, 377-382.

Rods, showing polar staining, occasionally club-shaped forms are seen. Non-motile. Gram-positive.

Plain gelatin colonies: Rarely develop. Serum gelatin stab: No liquefaction. Agar colonies: Minute, circular, almost transparent, raised, smooth, pearly white.

Agar slant: Thin, grayish, limited growth.

Loeffler's blood serum: Thin, grayish, adherent growth.

Broth: Clear, with slight, granular sediment.

Litmus milk: Unchanged.

Potato: No visible growth.

Indole not formed.

Nitrites not produced from nitrates. Acid from glucose, fructose, galactose, maltose and sucrose.

Not pathogenic.

Aerobic, facultative. Optimum 'temperature 37°C. Grows very slowly as lowas 18° to 25°C (Eberson, Jour. Inf. Dis., 23, 1918, 3).

Source: From normal and diseased coniunctiva.

Habitat: Probably identical with other species described from the skin and other parts of the body.

Corynebacterium hoagii (Morse) Eberson. (Bacillus X, Hoag, Boston Med. and Surg. Jour., 187, 1907, 10).
 Bacillus hoagi: Morse, Jour. Inf. Dis, 11, 1912, 284; Eberson, Jour. Inf. Dis, 23, 1918, 10.)
 Named for Hoag, the bacteriologist who first isolated the species.

Rods: 0 8 to 1.0 by 1.0 to 3 0 mierons, occurring singly. Show polar staining in the shorter forms while the longer forms are barred and slightly club-shaped.

Non-motile. Gram-positive. Gelatin colonies: Small, dull, pale pink, entire

Gelatin stab. Slight pink surface growth. No liquefaction.

Agar colonies: Small, pale pink, dull, granular, entire.

granular, entire.
Agar slant: Filiform, dull, pink growth
Broth: Turbid, with slight pink sedi-

Litmus milk: Slightly alkalıne, with

pink sediment. Potato: Dull, filiform streak

Indole not formed.

Nitrites not produced from nitrates Acid from glucose and sucrose but not

maltose, Blood scrum; Dull, filiform, pink

streak.

Aerobic.

Optimum temperature 30°C.

Source: From the throat. Air contamination of cultures. Habitat: Unknown.

6. Corynebacterlum acnes (Gilchrist)
Eberson. (Bacillus acnes Gilchrist,
Johns Hopkins Hosp. Repts, 9, 1901,
425, Actinomyces acnet Gilchrist, ibid,
425; Eberson, Jour. Inf. Dis, 25, 1915,
10, Fusiformis acnes Holland, Jour
Bact., 6, 1920, 233; Proposibacterium
acnes Bouglas and Gunter, Jour Bact,
52, 1916, 22) From M L. acne, the
dissace acne.

Rods, vary in dimensions, usually 0.5 by 0.5 to 2.0 microns, sometimes slightly club shaped. Show alternate bands of stained and unstained material Nonmotile. Gram-positive. Growth in culture media very feeble.

Best growth occurs in shake cultures with soft, slightly acid, glucose area.

Agar slant. Very small, circular transparent colonies which may later become rose-colored.

Loeffler's blood serum: Small, grayish colonies, which may later become rose-

Broth Clear

Litmus milk: Soft coagulum.

Potato · No growth in aerobic cultures, but nink streak in agaembic cultures.

Indole not formed.

Nitrites produced from nitrates.
Acid from glucose, sucrose (alight),
maltose, mannitol and inulin Produces
propionic acid (Douglas and Gunter.

loc cit)
Catalase produced

Microserophilic to anserobic.

Optimum temperature 35° to 37°C.

Pathogenic for mice and gives rise to characteristic lesions.

Source: From acne pustules Habitat: Sebaceous glands, hair fol-

lieles and acne pustules. Notes, Even before 1901, several authors reported finding bacteria in acno postules which were evidently diphtheroid in nature. Unna (Monatshefte f. prakt. Derm , 15, 1891, 232) found an organism in acre pustules which he gave the name of Plaschenincillus, Hodara (Monatshefte f. prakt. Derm . 18, 1801. 586) reported the presence of two types of bacteria in sene lesions, the second of which he called Flaschenkucelbacillus. Sabouraud (Ann Inst Past . 11, 1897. 131) cave a more accurate description of these diphtheroids which he reported to need an acid medium for growth. He called this bacterium, bacille de séborthie grasse (Bacillus sabouraud: Neveu-Lemaire, Précis Parasitol Hum . 5th ed .. 1921, 21),

Additional anscrobic species will be found in the appendix. These are Corpubate time the following the first following the first following the first following following the first following followi

terium acnes, and cleven species listed by Prévot (Manual de Classification et de Détermination des Bactéries Anaérobies. Monographie, Inst. Past., Paris, 1940, 199-204) as follows: Corynebacterum diphtheroides, C avidum, C. renale cumiculi, C. lymphophilum, C. hepatodystrophicans, C. parvum, C. anaerobium, C. granulosum, C. adamsoni, C liquefaciens, and C pyogenes bovis.

7. Corynebacterium pyogenes (Glage) Eberson. (Bacillus liquefaciens pyogenes boris Lucet, Ann. Inst. Past. 7, 1893, 327; Bacillus liquefaciens puogenes Lucet, ibid., 327, Bacillus liquefaciens Lucet, ibid , Bakterium der multipler Abszessbildung der Schweine, Grips, Ztschr f Fleisch- u Milchhyg., 8, 1898, 166; Bacillus pyogenes boris Kunnemann, Arch. f. wiss u prakt Tierheilk., 29, 1903, 128, Bacillus pyogenes Glage, Ztschr. f Fleisch- u Milchhyg . 15, 1903. 166, not Bacillus pyogenes Lucet, Ann. Inst. Past , 7, 1893, 327, Bacillus pyogenes suis Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 394, Bacterium hyopyogenes Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 394; Bacterium pyogenes suis Lehmann and Neumann, Bakt Diag , 7 Aufl , 2, 1927, 499; Bacterrum pyogenes Ward, Jour Bact, 2, 1917, 519, not Bacterium pyogenes Chester, Man Determ Bact, 1901, 184; Eberson, Jour Inf Dis. 23, 1918, 5; not Corynebacterium pyogenes Lewandowsky, Cent. f Bakt, I Abt, Orig, \$6, 1904, 473; Corynebacterium pseudopyogenes Ochi and Zaizen, Jour Jap Soc Vet Sci, 15, 1936, 12 and 16, 1937, 8) From Greek pyum, pus; gignomas, producing

For description see Brown and Orcutt, Jour. Exp. Med., 32, 1920, 244.

Rods: 0 2 by 0 3 to 2 microns in length Smallest forms appear as scarcely visible points (common in old abscesses). Chains formed Club forms may be present Non-mottle Gram-positive.

Serum gelatin: Liquelaction No growth on ordinary agar.

Scrum agar: Minute colonies after 36

to 48 hours. Surface colonies may increase to 3 mm in diameter. Colonies smoky brown by transmitted light and bluish-white by reflected light.

Bovine blood serum slants: Pit-like or more general areas of liquefaction.

Serum bouillon: Cloudy with fine focculent grayish flakes that form a sediment like a streptococcus culture.

Milk: Coagulation after 48 hours at 37°C, with acid at bottom of tube Separation of whey and peptonization.

Nitrites not produced from nitrates (Merchant, Jour. Bact., 30, 1935, 108).

Indole not formed.

Acid formed in serum bouillon from glucose, sucrose, lactose, and xylose but not from raffinose, inulin, mannitol and solicin.

Beta hemolytic, not hemoglobinophilic though growth is favored by proteins as egg albumen, scrum or blood (Brown and Orcutt, loc. cil.).

Optimum temperature 37°C. Growth range 20° to 40°C.

Intravenous injection of rabbits fatal. Aerobic as well as anaerobic growth Source: From bovine pus

Habitat: Found in abscesses in cattle, swine and other domestic animals.

8. Corynebacterium renale (Migula)
Ernst. (Bacillus renalis borts Bollinger,
in Enderlen, Zeit. f. Tiermed, 17, 1890,
346; Bacillus pydenaphritis boum (is)
Hofflich, Monatsh. f. prakt. Tierheilka. f.
1891, 356; Bacterium renale Migulo.
Syst. d. Bakt., 2, 1900, 204; Bacillus
renalis Ernst, Cent. f. Bakt., 1 Akt.,
Orig., 39, 1905, 550; Ernst, 1914, 40, 1908.
80; Corynebacterium renalis borts Irnst,
1914, 82.) From Latin renalis, kidney.

Description largely taken from Jones and Little, Jour. Exp. Med., 44, 1926, 11.

Rods: 0.7 by 2 to 3 microns. Normottle Usually in masses, rarely siegle. Becteria from tissues not as pleomorphic at those from the earlier transfer cultures although many show polar granuler or swollen ends. Cultures grown in broth show coccoid forms and beaded rolls with swollen ends. Gram-positive.

Gelatin: Grows poorly if at all. No liquefaction.

Agar: Small punctiform colonies

Agar slants: Raised, grayish-white, and dry growth (Jones and Little) Others

Blood scrum slants: Fine gray punctiform colonies in 24 hours at 37°C which are a hittle larger than on agar Streak scarcely 1 mm in width Glistening and slimy in fresh cultures No liquefaction.

Litmus milk: Reduction and coagulation from the bottom Slow digestion, becoming alkaline.

Broth: Sediment at end of 2 days with

Potato: Growth grayish-white, later, becoming a dingy yellow, turning the notate brown

Acid from glucose No acid from lactose, sucrose, maltose and mannited Some strains ferment fructose and mannose (Merchant, Jour Bact, 30, 1937,

Shows a close serological relationship with Corynebacterium pseudotuberculosis (Merchant). Amerobic.

Not pathogenic for laboratory animals No toxin produced

Optimum temperature 37°C.

Source Found in pyclonephritis in cattle

Habitat: Occurs in purulent infections of the urinary tract in cattle, sheep, horses and dogs

9. Corynebacterium pseudotubecculoisi (Buchanan) Eberson (Nocard, Bull
de la Soc Centr de méd Vet , 1885, 207,
Pseudotuberculose-Bakterien, Press,
Cent. f Bakt., 10, 1891, 568; Bacellus pseudotuberculosis ovis Lehmann and Neumann, Bakt. Diag., 1 Aud., 2, 1805, 362;
Bacellus pseudotuberculosis Buchanan,
Veter. Bact., Phila., 1911, 235; not
Bacillus pseudotuberculosis Eisenberg,
Bakt. Diag., 3 Aufl., 1891, 291; Eberson,
Jour. Inf. Diag. 25, 1918, 10; Coryneboterium oris Bergey et al., Manual, 1st
ed., 1923, 385; not Corynebocterium pseu-

databereulosis Bergey et al., Manual, 2ad ed. 1925, 304, Corynabacterjum preudotuberculosis boeis (an evident typographical error) Thomson and Thomson, Ann.
Pleaket-Thomson Res. Lab., 2, 1925, 192;
Corynebacterium pseudotuberculosis oris
Hauduroy et al., Diet. d. Bact Path.,
1937, 1957; Corynebacterium preises-nocards
Hauduroy et al., 1964, 1969. From Greek
pseudus, a falsebood; Latin tuberculum, a
small nodule. M. L. false tuberculum.

Common name Preisz-Nocard bacillus Slender rods: 0.5 to 0 6 by 1 0 to 3 0 merons, staining irregularly and showing clubbed forms. Non-motile. Grampositive

Gelatin colonies. Slight development

Gelatin stab: No liquefaction.

orange, folded, screate, dry
Locffler's blood scrum Small, yellow,
serrate colonies No honelaction

Broth: No turbidity. Granular sedinient. Pellicle formed (Carne, Jour. Path and Bact., 49, 1939, 316)

Litmus milk Unchanged

Potato: No growth

Nitrites not produced from nitrates.
Acid from glucose, fructose, galactose,
mannose, sucrose, lactose, maltose and

dextrin Some strains attack xylose.

Causes caseous lymphadenitis in sheep
and ulcerative lymphangitis in horses.

Forms an evotoun

Shows a close serological relationship with Corynebacterium renale (Merchant, Jour. Bact, 50, 1935, 199)

Acrobic, facultative

Optimum temperature 37°C. Source. From necrotic areas in the kidney of a sheep

Habitat Found in cascous lymphadenits in sheep and ulcerative lesions in horses, cattle and other animals

10 Corynebacterium kutscheri (Migula) Bergey et al. (Bacillus pseudotuberculosis murium Kutscher, Ztechf. Hyg., 18, 1891, 338; Bacillus pseudotuberculosis murium Lehmann and Keumann, Bakt. Dug., 1 Aufl., 2, 1896, 362; Bacterium kutscheri Migula, Syst. d. Bakt., 2, 1909, 372; Mycobacterium pseudotuberulosus Chester, Manual Determ. Bact., 1901, 355; Coryncbacterium murium Bergey et al., Manual, 1st ed., 1923, 386; Bergey et al., Manual, 2nd ed., 1925, 395.) Named for the bacteriologist Kutscher, who first isolated the species.

Rods with pointed ends, staining irregularly. Non-motile. Gram-positive.

Gelatin colonies: Small, white, translucent.

Gelatin stab. No growth on surface. White, filiform growth in stab. No liquefaction.

Agar colonies: Small, thin, yellowishwhite, translucent, serrate.

Agar slant: Thin, white, translucent Loeffler's blood serum: Abundant growth. Not peptonized.

Broth: Slight turbidity. Crystals of ammonium magnesium phosphate are formed.

Litmus milk Unchanged.

Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates

Aerobic, facultative.

Optimum temperature 37°C.

Source: From cheesy mass in lung of mouse.

 Corynebacterium murisepticum v. Holzhausen. (Cent. f. Bakt., I Abt., Orig., 105, 1927-28, 94.) From Latin mus, muris, a mouse; Greek septicus, putrefying, septie.

Slender rods: 1.2 to 1.5 microns in length, with polar granules. Grow out into long filaments. Non-motile. Gram-positive.

Gelatin stab: Feeble growth, with fimbriate outgrowth along line of puncture.

Egg glycerol broth Good growth.

Loeffler's blood serum: Good growth. Broth: Turbid.

Litmus milk: Acid. No congulation. Potato: Good growth. Indole not formed.

Nitrates not reported.

Acid from glucose, fructose, galactose, maltose, lactose, sucrose, inulin and mannitol. Arabinose and isodulcitel are not attacked.

Hydrogen sulfide formed.

Aerobic, facultative.

Optimum temperature 37°C. Habitat: Septicemia in mice.

12. Corynebacterium bovis Bergey et al. (B. pseudodiphtheria, Bergey, The Source and Nature of Bacteris in Milk Penn. Dept. Agr. Bull. 125, 1904, 11; Bergey et al., Manual, 1st ed., 1923, 383) From Latin bos. bovis, ox; of cattle.

Rods, slender, barred, clubbed, 0.5 to 0.7 by 2.5 to 3.0 microns. Non-motile Gram-positive.

Gelatin stab: Slight, gray, flat surface growth.

Agar colonies: Circular, gray, slightly raised, radiate, undulate, dry.

Agar slant: Thin, gray, filiform, dry

Broth: Slight granular sediment.

Litmus milk: Slowly becoming deeply
alkaline.

Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates No acid from carbohydrate media.

Blood serum: Thin, gray, filiform growth.

Causes rancidity in cream. Weakly lipolytic on tributyrin agar (Black, Jour Bact., 41, 1941, 99).

Optimum temperature 37°C.

Source: In fresh milk drawn directly from the cow's udder.

Nore: Miss Alice Evans (personal communication) states that the organism from the udder which she described a Bacterium tipolyticus (sio.) (Bacillus abortus var. Lipolyticus Evans, Jour. Inf. Dis., 18, 1916, 459; Bacterium abortus var. Lipolyticus Evans, Jour. 1917, 185; Evans, Jour. Inf. Dis., 22, 1918. 576: not Bacterium linoluticum Huss. Cent. f. Bakt., II Abt., 20, 1908, 474; Alcalinenes linglutieus Pacheco Revista da Sociedade Poulista de Med. Vet., 5. 1933. 9) was probably a Cormebacterium This is also regarded as probable by Steck (Die latente Infektion der Milchdruse, Hanover, 1930) and by Bendixen (Ztschr. f. Infektionskrankh. d. Haustier., 45, 1933, 196). Miss Evans also indicates that it is probable that the organism described by Bergey first in 1904 (loc. cit.) and later in the first edition of the Manual as Corunebactersum bavis was the same organism. This is further confirmed by Black (Jour Bact . 41, 1941, 99). A description of Bacterium livolyticum Evans will be found in the Manual, 5th ed . 1939, 803

13. Corynebacterium equi Magnussen (Magnusson, Arch f Terheik. 20, 22; Corynebacterium pyogenes (equi) Moissner and Wetzel, Deutsche Tierstill. Wehnschr., 31, 1923, 419, Corynebacterium (propenes) equi roseum Luti, 1614, 561; Mycobacterium equi Jensen, Proc. Linn. Soc. New So. Wales, 36, 1934, 33; Corynebacterium mognusson-holth Plum, Cornell Vet., 30, 1940, 15; Corynebacterium purulentus Holtman, Jour. Bact., 49, 1945, 161.) From Latin equius, horse.

Description from Dimock and Edwards, Kentucky Agri. Exper Stat, Bull. 333, 1932; Bruner and Edwards, ibid., Bull. 414, 1911; Merchant, Jour Bact., 30, 1935, 95; and Brooks and Hucker, Jour. Bact., 48, 1944, 309.

Rods variable according to medium Coccoid and ellipsoidal cells to rather long curved and sometimes clubbed forms. The latter are especially apt to occur in liquid media. Non-motile Gram-positive

Gelatin stab: Good growth. No liquefaction.

Agar colonies: Usually moist, smooth and glistening, tan to yellow (Brooks

and Hucker, loc. cit., p. 300) or pink to red chromogenesis (Merchant, loc. cit., p. 107)

Agar slant: Moist heavy growth which may run down the slant (Dimock and Edwards, loc. cit, p. 322).

Broth: Turbid with no pellicle and little sediment (Dimock and Edwards, loc. cit., p 322). Pellicle and final pH alkaline (Brooks and Hucker, loc. cit., p 309). Branched cells occur in 6 to 8 hour cultures in beath

Loeffler's blood serum: Good growth with tan to yellow chromogenesis No liquelaction.

Congulated egg yolk: Vigorous salmonpink growth Dryer than on agar, resembling wrinkled growth of tuberele

bacillus after two weeks.

Latmus milk: No change to slightly

Potato · Abundant growth, usually tan,

Indole not formed

mum 7° to 18°C.

Hydrogen sulfide produced on appro-

Nitrites produced from nitrates No

No acid from carbohydrate media However, glucose stimulates growth.

Sodium hippurate: Not hydrolyzed. Escular: Not hydrolyzed.

No evotoxin demonstrated in filtrate of broth cultures

No or slight hemolysis of horse blood, Not pathogenic for laboratory animals. Aerobic.

Aerobic.

Temperature relations Optimum 25° to 37°C. Maximum 37° to 45°C Mini-

Source Originally isolated from infectious pneumonia of foals.

Habitat Found in spontaneous pneumonia of foals and other infections in horses Also in swine, cattle and buffaloes

Nore: Jensen (los cit., 33) regards four cultures of soil bacteria isolated in Australia as identical with this organism. Because of the acid-fast staining of the cells, especially when grown in milk for 3 to 7 days, he places this species in the genus Mucobacterium. Most cocci retain the stain completely, while the rods take the counterstain, Jensen thinks the organism a widespread soil saprophyte which under certain conditions acquires pathogenic properties. He points out the close relationship of this organism to Racterium aurantium-roseum (Mededeel, Deli Proefstat te Medan, 7. 1912, 223) isolated from fermenting tobacco. He also regards this species as closely related to Mucobacterium coelacum Gray and Thornton. Red strains seem to be much like Bacillus rubrovertinctus Hefferan and Micrococcus (Staphylococcus) crythromuxa Zopf.

14. Corvnebacterium paurometabolum Steinhaus (Jour. Bact., 41, 1941, 763 and 783.) From Greek paurus. little, metabolc, change or little action.

Rods: 0.5 to 0.8 by 1.0 to 2.5 microns. occurring singly, in pairs and in masses Metachromatic granules present Nonmotile Gram-positive.

Gelatin stab. Slow liquefaction at surface

Agar colonies White to gray, entire, circular, small, dry, somewhat granular. Agar slant. Filiform to arborescent, thick, granular growth.

Broth Abundant granular sediment but no turbidity. Pellicle

Litmus milk: Alkaline

Potato · Thick, raised, drv. granular. profuse, gray to light cream-colored growth

Indole not produced.

Slight production of hydrogen sulfide. Nitrites not produced from nitrates.

No action on the following carbohydrates : Glucose, lactose, sucrose, maltose, fructose, mannitol, galactose, arabinose, xylose, dextrin, salicin, raffinose, trehalose, sorbitol, inulin, dulcitol, glyceml. rhamnose, adonitol, mannose, escula and inosital

Aerobic.

Slight alpha hemolysis.

Non-pathogenic for guinea pigs.

A special semi-solid medium, the main nutritive constituents of which were noteose pentone, rabbit serum, gelatu, minced rabbit kidney and carbohydrates, was used for the original isolation An incubation period of 4 to 7 days at 26°C was necessary for the initial isolation. Subsequent transfers to ordinary beelinfusion agar grew out in 24 to 48 hours

Source: From media inoculated with the mycetome and ovaries of the bedbug, Cimex lectularius L. A very similar diphtheroid strain was isolated from the alimentary tract of the bagworm, Thyridonterur enhemeraeformis Haw.

Habitat: Distribution in nature unknown.

\*15. Corynebacterium insidiosum (Me-Culloch) Jensen. (Aplanobacter int diesum McCulloch, Phytopath., 15, 192 497; Bacterium insidiosum Stapp, Sorauer, Handb. der Pflanzenkr., 2, Aufl., 1928, 178; Phytomonas insidios Bergey et al., Manual, 3rd ed , 1930, 278 Jensen, Proc. Linnean Soc. of New & Wales, 59, 1934, 41.) From Latin 17 sidiosus, deceitful, dangerous.

Also see McCulloch, Jour. Agr. Res

33, 1926, 502.

Rods: 0.4 to 0.5 by 0.7 to 1.0 micron Capsules present. Non-motile Gram positive.

Gelatin: Slow liquefaction.

Beef agar colonies: Pale yellow, circu lar, smooth, shining; edges entire; viscid Blue granules found on the medium

Milk Congulated after 16 to 20 days No digestion. An apricot yellow sediment is deposited on the walls of the tube.

<sup>\*</sup> Descriptions of Species nos 15 to 20 inclusive prepared by Professor Walter II Burkholder, Ithaca, New York.

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Diseases, 1913, 30; Aplanobacter michiganense Erw. Smith, Bacteria in Rel. to
Plant Dis., 5, 1914, 161; Phytomonas
michiganensis Bergey et al., Manual,
1st ed., 1923, 191; Jensen, Proc. Linnean
Soc. of New So. Wales, 59, 1934, 47;
Erwinia michiganeae, incorrectly attributed to Bergey by Jensen, loc. cit.,
47.) Latinized, of Michigan, where the
disease produced by this pathogen was
first reported.

Description from Bryan, Jour. Agr. Res., 41, 1930, 825.

Rods: 0.6 to 0.7 by 0.7 to 1.2 microns. Non-motile. Capsules. Gram-positive. Characteristic angular growth with branching and club-shaped cells (Jensen, loc. cit.).

Beef agar colonies: Growth slow, mustard yellow, smooth, glistening, butyrous.

Chromogenesis. Develops yellowishbrown, light ochre-yellow to sepia brown colors on suitable media (Jensen, *loc* cit.).

Gelatın Slow lıquefactıon

Broth Turbidity slow and moderate. Milk. Slow coagulation. No peptonization.

Nitrites not produced from nitrates.
Utilizes peptone, but not ammonia,

Utilizes peptone, but not ammonia, nitrite, nitrate, tyrosine, asparagine or glutamic acid (Mushin, Austral. Jour. Exp. Biol and Med., 16, 1938, 326).

Indole not produced No H<sub>2</sub>S produced.

Acid from glucose, sucrose, galactose, fructose, maltose, and slight acid from lactose, glycerol and mannitol.

Starch: Very weak diastatic action. No growth in 3 per cent salt

No growth in 3 per cent salt Optimum temperature 25° to 27°C Maximum, 33°C Minimum, 1°C

Aerobic.

Source: From the bacterial canker of tomato.

Habitat: Pathogenic on tomato

17a. Corynebacterium michiganense var. saprophyticum Jensen (loc. cit., 48). Grows more rapidly and with more moist growth, has a higher temperature manimum and stronger proteolytic activity than the pathogenic strains. From grass soil in Australia.

18. Corynebacterium rathayi (Ers. Smith) Dowson. (Aplanobacter 11 thayi Erw. Smith, Science, 53, 1913, 63, and Bact. in Rel. to Plant Dis., 5, 1914, 155; Phytomonas rathayi Bergey et al, Manual, 1st ed., 1923, 192; Bacterium rathayi Stevens, Fungus Dis. of Plant, 1925, 21; Dowson, Brit. Myc. Soc. Trans. 25, 1942, 313.) Named for E. Rathay, the Austrian plant pathologist who first isolated the species.

Rods: 0.6 to 0.75 by 0.75 to 1.5 merons Non-motile. Not acid-fast. Capsules Gram-positive.

Gelatin: Slow liquefaction after 7

weeks.

Agar colonies: Small, yellow, slon

Agar colonies: Small, yellow, sor growing. Milk: Growth slow. Yellow ring

Litmus milk: Alkaline and reduced.
Nitrites are produced from nitrates
Potato plugs: Good, yellow, vised
growth.

Acid but no gas from glucose, sucrose and lactose.

Cohn's solution : No growth.

Heavy inoculum necessary in medis.

Source: Isolated from slimy heads of
Dactylis glomerata by E. Rathay in
Austria.

Habitat: Pathogenic on Dactylis glo-

merada.

Notra: Bacillus mucilaginosus kedriae Aujeszky, Botanikai Kozlemenyk,
13, (Foreign Supl. 41), 1914, 88, Prubi13, (Foreign Supl. 41), 1914, 88, Prubi14, No. 301, Set. Bot. Mus. Nat. Hus;
Budapest, 1915. The description of the
bacterium is possibly that of the sprephyte, Pseudomonas fluorecens, but the
description of the disease is that caused
by Corynebacterium rathayi. The sprimen in schedis is a head of grain that
appears to be infected with Corynebaterium rathayi.

19. Corynebacterium sgropyri (O'Gara) comb. nos. (Aplanobacter agropyri O'Gara, Ph, topath, 6, 1916, 343; Phylomonas agropyri Bergey et al., Manual, ist ed., 1923, 190; Bacterium agropyri Stapp, in Sorauer, Handbuch d. Pflancenkrankheiten, 5 Aufl., 2, 1928, 37.) From Greek agros, field and puros, wheat; M. L. Agropyron, wheat grass.

Rods: 0.4 to 0 6 by 0 6 to 1.1 microns Capsules. Non-motile. Gram-variable

Gelatin: No liquefaction Nutrient agar slant: Meager, yellow,

very viscid growth.

Broth: Light clouding with yellow pre-

cipitate.
Milk: Little changed Yellow sedi-

ment formed.

Nitrites are produced from nitrates

Acid but no gas from glucose, lactose,

Acid but no gas from glucose, lactos sucrose and glycerol. Starch: Hydrolysis feeble

Optimum temperature 25° to 28°C

This species is very similar to and may be identical with Corynebacterium rathayi Dowson.

Source: From alimy heads of wheat grass.

Habitat: Found on wheat grass, Agropyron smithii.

20. Corynebacterium fascians (Thiord) Dowson. (Phytomonas faccians Tillord, 5th Rept. Ohio Agr Evp Sta Bull. 5d1, 1295, 23; Jour. Agr Res. 55, 1936, 23; Unanined pathegen, Lacey, Ann. Appl. Biol., 25, 1936, 308, Dowson, Brit. Mye. Soc. Trans. 25, 1912, 313; From Latin facricio, producing fasciation

Rods: 0.5 to 0.9 by 1.5 to 4.0 microns Non motile. Gram-positive

Gelatin No liquefaction

Putato glucose agar colonies Light cream-colored colonies appear after 72 hours Punctiform, circular, later cadmium sellow to deen chrome

Nutrient agar slant: After one week streak is filiform, flat, dull to glistening, arreath, opaque, cream-colored, and butyrous Broth: Slightly turbid Fragile pelliele with distinct rim.

Milk: Litmus becomes blue Other changes slight.

hanges slight.
Nitrites are produced from nitrates

Indole not formed.

Hydrogen sulfide is produced.

Acid but no gra from glucose, gralactose, fructose, mannose, arabinose, xylose, maltose, sucrose, glycerol, mannitol and destrin No acid from rhamnose, lactose, raffinose and inulin.

Starch not hydrolyzed Grows in Sper cent salt

Optimum temperature 25° to 28°C

Aerobic

Source: Described from 15 single cell isolates from fasciated growths on sweet peas.

Habitat. Pathogenic on sweet per, chrysanthemum, geranium, petunia, tobacco, etc

21 Corynebacterium helvolum (Zimmerman) Kisskalt and Berend (Bacillus helvolus Zimmermann, Bakt unserer Trinke u. Nutzwässer, Chemnitz 1, 1500, 22, Bacterium helvolum Lehmann and Neumann, Hakt Diag 1 Aufl 2, 1596, 251, Kisskalt and Berend, Cent f Bakt, 1 Abt. Org. 81, 1918, 416, Flatsbacterium helvolum Bergey et al, Manual, 1st ed., 1923, 114) From Latin helvus, of a light bay color.

Original description supplemented from Jensen, Proc. Linn. Soc. New So. Wales, 89, 1931, 37

Rods 0.5 by 10 micron, occurring singly. Show angular arrangement due to snapping diamon. Variable in neces-

phology. Non-motile Gram-positive Gelatin colonies Small, circular, yellowish gray Liquelaction

Gelatin stab: Slight development slorg the stab Napilorm Inquelaction

Ager colonies Circular, pale yellow, smooth, slightly convex.

Agar slant: Pale yellow, plumese to spending, meist, undulate.

Milk agur: Growth fair to very abun-

dant, white to pale yellow. Some strains form a pink pigment. Protectvtic zones clear and broad after 4 days.

Asparagine agar: Scant to good growth, smooth, glistening, white and ereamcolored to lemon-vellow or even dull nink.

Broth: Turbid, with gray ring and yellowish sediment. After four days the sediment contains long, curved and branching rods. May resemble small mycelia.

Litmus milk: Slightly acid, with soft coagulum, becoming alkaline; peptonized. Litmus reduced.

Potato Pale yellow, moist, plumose growth, becoming rough, dull, Slimy variants noted in one strain. A myceloid variant with dry wrinkled growth was found in another strain.

Indole not formed.

Nitrites not produced from nitrates.

Acid from glucose, glycerol and mannitol. Usually from arabinose, sucrose, galactose, fructose,

Aerobie, facultative.

Hydrogen sulfide produced on appropriate media

Optimum temperature 25°C. Usually grows at 37°C. Source Originally isolated from water.

Habitat · A common soil Corunebacterium.

22. Corynebacterium fimi (McBeth and Scales) Jensen. (Bacterium fimi McBeth and Scales, Bur. of Plant Ind., U. S. Dept. Agr., Bull. 266, 1913, 30; Cellulomonas fimi Bergey et al , Manual, Ist ed., 1923, 166; Bacillus fim: Holland, Jour. Bact., 5, 1920, 218; Jensen, Proc. Linn. Soc New So. Wales, 59, 1934, 48.) From Latin fimus, dung

Description from Jensen (loc cit.) who studied an authentic strain

Rods present typical diphtheroid appearance with angular arrangement, 04 to 0.5 by 1.2 to 2.5 microns. Many longer, fregular, curved, club-shaped branching cells on Sabouraud's (whey) agar. Non-motile. Gram-negative (McBeth and Scales). Gram-variable like some other corynebacteria (Jensen).

Gelatin colonies; Small, round, becoming lobate. Slow liquefaction.

Gelatin stab: Granular yellow growth Infundibuliform liquefaction.

Cellulose agar colonies: Circular, raised, smooth, glistening, gray, entire Agar slant : Smooth, glistening, white to

lemon-vellow growth. Glucose and Sabouraud's agar : Growth less abundant and cream-colored.

Asparagine agar: Very scant growth, narrow, thin, glistening, white.

Broth: Uniform turbidity, soft creamcolored to yellow sediment after 3 weeks Litmus milk: Coagulated at 3 weeks at

37°C. Not at 28° to 30°C. Faintly seid. Potato: Slow cream-colored to yellow growth.

Indole is formed.

Nitrites are produced from nitrates Ammonia is produced in peptone solu tions.

Diastatic action doubtful.

Acid from glucose, fructose, arabinese, xylose, maltose, lactose, sucrose, raffinose, melezitose, dextrin, starch, salicin and glycerol. None or feebly produced from mannitol and dulcitol.

Causes rapid disintegration of cellulose (filter paper) in a 0.5 per cent peptone solution.

Aerobic, facultative.

Optimum temperature 20°C (McBelh and Scales). Better growth at 37°C than at 25° to 30°C (Jensen).

Source: Probably isolated from soil Found in soils of Southern Cablornia (McBeth, Soil Sci., 1, 1916, 443).

Habitat : Soil.

Bacterium liquatum McBeth and Scales (McBeth and Scales, Bur. Plant Ind. U. S. Dept. Agr., Bull. 206, 1913, 32; Manada Rergey et al., Min arded

only tween

the two species by the unsum was that Bacterium liquatum produced \$ vellow chromogenesis more readily This, however, does not appear to have occurred any more frequently than took place with the authentic culture of Racterium fimi when tested by Jensen (loc cit.).

23. Corynebacterium tumescens Jen sen. (Jensen, Proc. Lann Soc New So. Wales, 59, 1931, 45.) From Latin tumescens. swollen.

Rods show characteristic extemorphosis in glucose agar. Sabouraud's (whey) agar and milk agar. Cells after 18 to 21 hours at 28° to 30°C are curved, often branched, show an angular arrangement 0.5 to 0 8 by 2 5 to 6 0 microns to 3 days many spherical to club shaped cystites (3 microns in diameter) arise as local swellings of the rods Staining in tensely at first, they gradually change into large, irregular, poorly stained ghost cells which show deeply staining belts and granules Irregular less anollen deeply stained rods and small coect (0 \$ to 0.5 micron) which resemble the gran ules in the custiles are also present These coccinre living cells Non motile Gram-mative.

Gelatin colonies, Small, opaque, sel low. Liquelaction after 3 to 4 weeks

Milk agir: Cystites develop in almost pure culture. These sometimes have 2 to 4 small encer attached to the wall so that they look like budding yearts. When transferred to fresh agar, exstates either fail to grow or germinate with 2 to 4 slender germ tubes which regenerate the risks Custifes are produced most abundantly at

37°C, symptomes not at all at 16° to 15°s. Saloumud's arar : Castates cometimes 6 to 5 mirrons in diameter. Growth may he cream colored or even grayish pink

Asparagine agar Greath thin, flat, medat, coloriesa.

Both: Paint uniform turbidity, after 2 to 3 weeks, a wift white to eream colored schment.

Milk: Thin white ricz around surface Sift engulation after Is to 20 days later, slow digretion Faintly and

Potato: Slow but eventually good growth, restricted, glistening, viscid. cream-colored to gray ish-orange.

Acid from glucose, arabinose, galactose, maltose and elycerol; occasionally from sucmse and mannital

Nitrates produced from nitrates Optimum reaction pH 6.2 to 6.8.

Slimy variants produced after 172 days growth in lithium solution

Source: Two strains from grass soils and one from garden soil in Australia Habitat Soil

21 Corynebacterium simplex Jensen.

(Proc Iann. Soc New So Wales, 59, 1931, 43 ) From Latin symplex, simple. Rods : 0.1 to 0 5 by 3 0 to 5 0 microns.

curved and in parallel bundles No branching in older cultures but the cells grow shorter, becoming almost coccoid Angular arrangement motile Gram-positive.

Gelatin : Colonies very small l'iliform growth along stab. Liquefaction after 4

Asparagine agar Tair to good growth. becoming moist and elistening. No nice

Glucose agar: Abundant Spreading, smooth, glistening, creamcolored to grayish-yellon.

Broth Uniform turbidity, gravishvellow, viscid redin ent.

Milk Vellowish rice around surface No congulation Complete digration after 10 to 12 days Reaction reutral

Nitrates produced from natrate-Starch is not hydrolyzed

Acul from sucrose Alkalue reaction in other suche broths

Excellent growth at 37'C

Resembles Corynchacterson flameria. sum in cultural characters but dies not form fore filaments

Source. I'mm grass roll and red roll from Goff the Australia Habitat Sil.

25 Cotynebattetium flamertosem

Jersen (Per lurn he

Wales, 59, 1934, 42.) From Latin filamentosus, full of threads.

B Rods: Variable in shape. Young cells typically curved, vibrio-like, 0.5 to 0.8 by 2.0 to 7.0 microns, sometimes longer and branched. Always in parallel bundies. Usually non-motile but a few cells exhibit a peculiar oscillatory or rotatory movement Gram-positive.

Gelatin: Colonies small, spherical, entire. Filiform white growth in stab. Liquefaction slow starting at end of 7 days.

Asparagine agar: Good characteristic growth, widely spreading, central part convex, smooth, glistening, white, sending dendritic projections into the broad marginal part. Usually produces light greenish-vellow soluble pigment.

Glucose agar: Growth less vicorous than on asparagine agar, flat, creamcolored to gravish-vellow, viscid.

Sabouraud (whey) agar: Similar to glucose agar.

Potato · Scant to no growth, flat, glistening, cream-colored to gravish-vellow, surrounded by a white halo.

Broth · Paint uniform turbidity. Soft. flaky, cream-colored sediment.

Milk: White to cream-colored surface ring and sediment. No coagulation. Digestion in 2 to 4 weeks. Neutral to faintly acid

May produce nitrites from nitrates.

Starch is not hydrolyzed.

Acid from glycerol and arabinose. Strong and rapid alkaline formation in other sugar media

Optimum reaction pH 5.4 to 5.5.

Excellent growth at 37°C.

Aerobic.

Regarded as being much like Vibrio lingualis Eisenberg and Bacterium racemosum Zettnow.

Source: From red soil from Griffith, Australia.

Habitat : Soil.

Appendix I:\* The following four species of plant pathogens have an unusual combination of characters in that they are reported to be Gram-positive and polar flagellate. Cultures of two of the four species have been available for study and these and other characters have been rechecked by several persons. Corunebacterium flaccumfaciens shows many wedgeshaped cells and longer cells with a slight curve. It is motile with a single polar flagellum and shows Gram-positive with commonly used procedures for Gram-staining. Corynebacterium poinsettiae shows a straighter form of cell but in other characters is like C. flaccumfaciens. Prof. W. H. Burkholder and Dr. M. P. Starr really feel that these organisms are most closely related to other more typical corynebacters They are therefore placed for the present in this appendix, although by the characters used in the keys they would be placed in Pseudomonadaceae.

1. Corynebacterium hypertrophicans (Stabel) comb. nov. (Pseudomonas hyperfrophicans Stahel, Phyt. Ztschr., 6, 1933, 445; Phytomonas hypertrophicans Magrou, in Hauduroy et al., Dict. d Bact. Path., Paris, 1937, 367.) From Greek hyper-trophe, hypertrophy.

Rods: 0 6 to 0 8 by 1.2 to 2 8 micross Motile with a polar flagellum. Bipolar

staining. Gram-positive. Gelatin: No growth.

Agar colonies: Slow growing, circular,

raised, wet-shining, white. Broth plus sucrose: Growth good. No

pellicle. Milk: No visible change.

Nitrites not produced from nitrates

Indole not formed.

No H2S produced.

Acid but no gas from glucose, fructose and sucrose. No acid from lactose and glycerol. The acids from sucrose are lactic and formic

Prepared by Prof. Walter H. Burkholder, New York State College of Agriculture, Ithaca, New York, May, 1945.

Aerobic.

Source: From witches' brooms.

Habitat: Pathogenic on Eugenia latifolia.

Corynebacterium flaccumfaciens (Iledges) Dowson. (Bacterium faccum-faccuns Iledges, Science, 55, 1922, 433, Phytopath., 16, 1926, 20; Phytomonos flaccumfaccuns Bergey et al., Manual, 1st ed., 1923, 178; Feeudomonas flaccumfaccuns Stevens, Plant Diseases of Fungs, 1925, 27; Dowson, Brtt. Myc Soc Trans., 25, 1942, 313. From Latin flaccus, flabby or willted; facto, to make; producing a will.

Rods: 0.3 to 0.5 by 0.6 to 3 microns. Motile with a single polar flagellum; also non-motile (Adams and Pugsley, Jour. Dept. Agr. Victoria, 32, 1934, 306) Gram-rossitive.

Gelatin, Liquefaction feeble.

Beef agar slants: Rather moderate growth, glistening, flat, smooth, viscid and vellow.

Broth: Moderate turbidity in 24 hours Pellucia formed.

Milk. Acid curd and slow peptonization.

on. Nitrites not produced from nitrates.

Indole not formed No ILS formed.

Acid from glucose, lactose, sucrose and

Starch not hydrolyzed.

Slight growth in 5 per cent salt Optimum temperature, 31°C Maxi-

mum temperature 36° to 40°C.
Distinctive character: A strict vascular

parasite of the bean.
Source: From wilted bean plants from

Source: From wilted bean plants from South Dakota.

Habitat Causes a wilt of beans and related plants.

3. Corynebacterium poinsettiae Starr and Pirone. (Phytopath, 32, 1912, 1080; Phytomonas poinsettiae, ibid.) From M. I., old genus Poinsettia.

Rods: Average cells 0.3 to 0.8 by 1.0 to 3.0 microns. Pleomorphic with some cells 8.5 microns in length. Granules

and capsules present. Motile with 1 (rarely 2) polar or lateral flagellum. Gram-positive.

Gelatin: Liquefaction.

Loeffler's blood-serum: Liquefaction. Beef-extract agar colonies: Round, slightly convex, 0.1 to 1.0 mm in diameter, edges entire, smooth, non-viscid,

colorless and almost transparent.

Potato glucose agar slants: Moderate growth, filiform, glistening, non-viscid, salmon to flesh color.

Beef-extract broth: Turbid in 24 hours, abundant pale salmon sediment. No pellicle

Milk: Slight acidity but no other visible change for 2 weeks, then a soft curd, reduction of litmus, and complete peptonization.

Indole not produced

Nitrites not produced from nitrates. Hydrogen sulfide not formed,

Sodium hippurate not hydrolyzed.

Asparagine not utilized as carbonnitrogen source. Uric acid not utilized;

urea not bydrolyzed No lipolytic activity.

Voges-Proskauer test negative.
Methyl red test negative

Moderate to abundant acid, but no gas, from glucose, fructose, mannose, galactose, sucrose, multose, celibbiose, melibiose, rafinose, glycerol, erythriol, salicin and amygdalin; weak acid from arabinose, xylose, lactose, trahalose, devirn and adonitol; no acid from rhamnose, fucose, inulin, glycgen, manntol, dulcitol, sorbitol and inostol.

Starch hydrolyzed.

No action on cellulose. Tellurite reduced.

Acrobic.

Growth occurs after 24 hours from 15°C to 36°C; after 48 hours from 7°C to 12°C. No growth above 36°C or below 7°C at the end of a week.

Source: Fourteen cultures isolated from diseased stems of poinsettia, Euphorbia pulcherrima

Habitat: Causes a canker of stems and spots on leaves of the poincettia. Corynehacterium tritici (Hutchinson) comb. nov. (Pseudomonas tritici Hutchinson, India Dept. of Agr., Bact. Ser., 1, 1917, 174; Phytomonas tritici Bergey et al., Manual, 3rd ed., 1930, 248; Bacterium tritici Elliott, Bacterial Plant Pathogens, 1930, 234.) From Latin triticum, wheat; M. L., from the genus Triticum.

Rods 0 8 by 2.4 to 3.2 microns. Motile with a polar flagellum. Gram-positive. Gelatin: No liquefaction.

Agar colonies Bright yellow becoming orange, glistening, moist, margins entire. Agar brownish

Broth Turbid. Thin pellicle. Milk Yellow surface and yellow pre-

cipitate. Little change.

Nitrites produced from nitrates. No H<sub>2</sub>S produced.

Acid but no gas from glucose and lactose.

This species is very similar to and may be identical with Corynchacterium rathayi Dowson.

Source: From slimy heads of wheat in India.

Habitat: Pathogenic on wheat, Triticum aestivum

\* Appendix II: By the use of names or by the descriptions given, authors have indicated that the following are related to the species placed in Corynebacterium Many are incompletely described and may be identical with other recognized species

Bacillus alcalifaciens Kurth. (Bacillus pseudodiphtheriticus alcalifaciens Kurth., Ztschr. f. Hyg, 28, 1898, 429; bid., 431) From patients suspected of having diphtheria

Bacillus arium Migula (Bacillus de la diphthérie aviaire, Loir and Ducloux, Ann. Inst Past, 8, 1834, 599, Bacillus diphtheriae avium Kruse, in Flügge, Die Mikroorganismen, 2 Aufl, 2, 1896, 410; Bacterium diphtheriae arium (sit) Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1807, 75, Migula, Syst d Bakt., 2, 1900, 750.) Considered the cause of a diphtheria-like disease of birds in Tunis. Motile. Not now regarded as belonging in Corymebacterium (Andrewes et al., Diphtheria, London, 303).

Bacillus claratus Kruse and Pasquale (Kruse and Pasquale, Ztechr. I. Hyg. 18, 1894, 50 and 62; not Bacillus classus Migula, Syst. d. Bakt., 2, 1900, 591.) From the heart blood, kidney, etc., daring autopsy of a person who deed will liver abscesses following Egptan dysentery. This is a pseudodiphered (Kruse, in Fluige, Die Mikroorganisme, 3 Aufl., 2, 1806, 477) but is confused by Eberson (Jour. Inf. Dis., 28, 1918, 5) and Thomson and Thomson (Ann. Pickit Thomson Res. Lab., 2, 1926, 63) with

1894, 290) from boiled milk and man.

Bacillus clavatus by Migula (loc. cnt)
in 1900.

Bacillus crassus Lipschütz. (Lipschütz, Bakt. Grundriss und Altas der Geschlechtekrankheiten, Leipzig, 1913, b4; Plocamobacterium crassum Lön, Wiener klin. Wehnsehr., 53, 1929, 733.

dant Gram-positive bacillus fount audeus vulvae acutum It is the type species (monotypy) of the genus Phocamobacterium Löwi (loc. ct.) Accading to Löwi this organism liquefies cogilated blood serum and Lipschlut (Ceat f. Bakt., I Abt., Orig, 88, 1922, 5) reports that, unlike lactobacilli, this organism vull grow on protein media without the addition of sugar. Presumably therefore it is not a lactobacillus and is not identical with Doederlein's bacillus as claimed with Doederlein's bacillus as claimed

<sup>\*</sup> Prepared by Dr. R. F. Brooks, New York State Experiment Station, Genera, New York, September, 1938; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, March, 1945

by Lehmann (loc. cit.) It may belong in Corunebacterium. See Bacillus vaginae Kruse.

Bacıllus diphtheriae vitulorum Flügge (Bacillus der diphtherie beim Kalbe, Löffler, Mitt. a d. kais Gesundheitsamte, 2, 1884, 421; Flugge, Die Mikroorganismen, 2 Aufl., 1886, 265 ) From a disease of calves.

Bacillus diphtheroides Klein. (Cent. f. Bakt , I Abt , 28, 1900, 418 ) From bovine mastitis. Presumably identical with Corunebacterium progenes according to Eberson (Jour Inf Dis., 25, 1918, 6).

Bacillus endocarditis griseus Weichselbaum. (Weichselbaum, Beiträge z path. Anat u. aligem. Path., 4, 1887, 119.) From a case of endocarditis. A motile form Regarded by Kruse (in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 433 and 479) as a diphtheroid. Because of its motility, it is not so regarded by

Eberson (Jour. Inf. Dis., 23, 1913, 4). Bacillus pseudodiphtheriticus acidum actens Kurth. (Ztschr. f. Hyg. 28. 1898, 431.) From patients suspected of

having diphtheria.

Bacıllus pseudodiphtheriticus genes Jacobsen. (Ann. Inst. Past., 23, 1908, 308) From feces. Reported to be a vigorous gas former. Eberson (Jour Inf. Dis , 23, 1918, 9) thinks this was an impure culture.

Bacıllus septatus Gelpke, (Gelpke, in v. Graefe, Arch f. Opthal , 42, 1896, No 4; Bacterium septatum Gelpke, Arb. bakt. Inst. Karlsrube, 2, Heft 2, 1898, 73) From acute epidemic catarrh. Presumably identical with Corynebacterium zerose according to Eberson (Jour. Inf. Dis., 23, 1918, 3).

Bacıllus variabilis lymphae vaccinalis Nakanishi, (Nakanishi, Cent. f. Bakt., I Abt., Orig., 27, 1900, 641; Corynethrix Czaplewski, Deutsche Wchnschr , 26, 1900, 723 ) From ealf vaccine lymph. The organisms listed here as Corynebacterium lymphae raccinalis. Corynebacterium taccinae and Bacillus variabilis lymphae raccinalis are probably identical.

Bacillus zerosis variolae Klein. (Rept. Local Gov. Board, London, 20, 1890, 219, quoted from Thomson and Thomson, Ann. Pickett-Thomson Res. Lab., 2, 1926, 121.) From vaccine pustules.

Bacterium acnes Migula. (Bacillus der Akpe contagiosa des Pferdes, Dieckerhoff, Grawitz, Arch. f. pathol. Anat. u. Physiol . 102, 1886, 148; Bacillus grawitzii Trevisan, I generi e le specie delle Batteriacee, 1889, 13; Bacillus acnes-contagiosae Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 445; Migula, Syst d Bakt , 2, 1900, 385; Bactersum grawitzi Chester, Manual Determ Bact., 1901, 154) From pus and scabs of pustules in acne-contagiosa in horses.

Bacterium candidus Galli-Valerio. (Cent. f. Bakt., I Abt , Orig , \$6, 1904. 465.) From infected leg, but not con-

sidered causative.

Bacterium coelicolor Müller (Muller, Cent. f Bakt., I Abt., Orig., 46, 1908, 195. Becillus coelicolor Godfrin, Contribution à l'étude des bactéries bleues et violettes, Thèse, Nancy, 1934 ) Contaminant on serum agar plate.

Bacterium columbarum Migula. (Bacillus der diphtherie bei der Taube, Löffler, Mitt a d. kais, Gesundheitsamte, 2, 1884, 421, Bacillus diphtheriae columbarum Flugge, Mikroorganismen, 2 Aufl., 1886, 263; Bacillus diphtheriae-columbarum Trevisan, I generi e le specie delle Batteriacce, 1889, 13. Bacterium diphtheriae columbarum Chester, Ann Rept. Del Col. Agr. Exp Sta , 9, 1897, 84, Migula, Syst d Bakt , 2, 1900, 3S1, not Bacterium columbarum Chester, Manual Determ. Bact., 1901, 141; Bacterium diphtheriae Chester, Man Determ Bact, 1901, 141; not Baciersum diphtheriae Migula, Syst d. Bakt., 2, 1900, 499 ) Associated with diphtheria in pigeons. Andrewes et al

(Diphtheria, London, 1923, 393) state that this organism does not belong in Bactersum muris Klein. (Cent. f.

Corunebactersum.

Bakt., I Abt., Orig., 33, 1902, 488; Bacillus muris Mellon, Jour. Bact., 2, 1917, 305.) Causative agent of hepatized lung in white rat.

Bacterium pseudopestis murium Galli-Valerio. (Cent. f. Bakt., I Abt., Orig., 68, 1913, 188.) Causative agent of thyrold infection in rats Gram-negative

Bacterium ribberti Migula. (Bacillus der Darmdiphtherie des Kaninchens, Ribbert, Deutsch. med. Wochnschr., 18, 1887, 141; Bacillus diphtheriae cuniculi Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 412; Bacterium diphtheriae cuniculi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, St; Migula, Syst. d. Bakt., 2, 1900, 360; Bacterium cuniculi Chester, Man. Determ. Bact., 1901, 141.) Associated with a diphtheritic inflammation of the intestines in rabbits.

Coccobacillus diphtheroides Manteufel.
(Diphtheroid bacilli, Collis, Sheldon and Hill, Quart Jour. Med., Ser. 2, 1, 1932, 511; Kokkobacillus diphtheroides Bertrand, Med. Welt, 8, 1934, 150, Manteufel, Cent. f Bakt, I Abt., Orig., 188, 1937, 305) From polyarthritis.

Comma variabile Heurlin. (Heurlin, Bakt Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wochnerinnen. Helsingfors, 1910, 145.) From genital canal

Corynebacterium acidum Eberson. (Bacillus diphtheroides brevis Graham-Smith, Jour Hyg., 4, 1904, 258, Eberson, Jour. Inf. Dis , 23, 1918, 9.) From large abscess in mouth and ear.

Corynebacterium adamsoni Prévot. (Bacillus D, Adamson, Jour. Path. and Bact, 22, 1919, 350 and 392, Prévot, Ann. Inst. Past., 60, 1938, 394.) From infected war wounds.

Corynebactersum album Belenky and Popova. (Cent. f. Bakt, I Abt, Orig., 118, 1930, 444) From normal skin of calves and small-pox vaccine.

Corynebacterium angerobium Prévot. (Bacillus anaerobius diphtheroides Massini, Ztschr. f. gesammte exper.

Med., 2, 1913, 81; Prévot, Ann. Inst. Past., 60, 1938, 304.) From a complicated case of otitis media.

Corpnebacterium annamensis Hauder roy et al. (Gillon, Thèse pour le Detorat Vetérinaire, École Nationale Vétéinaire de Toulouse, France, 1931, Hauduroy et al., Dict. d. Ruct Path, Paris, 1937, 145.) Causative agent of a toxic abdominal infection of sheep in Annam, French Indo-Chins.

Coryachacterium arthritids muss Fischl, Koech and Kussat. (Itsch. I. Hyg., 118, 1931, 421; Coryachactaium arthritidis-muris Hauduroy et al., Dat. d. Bact. Path., 1937, 147.) Causium agent of infected ankle joint in white mousse.

Corynebacterium ascitis Eberson. (Jour. Inf. Dis., 23, 1918, 16) From ascitic fluid.

Corynebacterium aurantiacum Eberson (Jour. Inf. Dis., 23, 1918, 14) Onagered growth. From lymph nodes, one culture from gland in Hodgkin's desease but not specific for the disease.

Corynebacterium auris (Graham-Smith) Eberson. (Bacillus auris Graham-Smith, Jour. Hyg., 4, 1904, 258; Eberso, Jour. Inf. Dis., 23, 1918, 8.) Indole is formed. From pus of ears of scale fever patients.

Corynebacterium aridum (Eggett)
Prévot. (Bacteroides aridus Eggett)
Jour Bact., 50, 1935, 293; Prévot, An.
Inst. Past., 60, 1933, 394.) Forus 43
in some media. From the human intet
tine. Pederson (Jour. Bact., 50, 1934
478) secured a culture of this specie
from Eggerth, and found that it fer
mented glucose with the production of
higher fatty (presumably butyric) acids,
and lactic acid. The species should
probably be placed in Butyribacterium
probably be placed in Butyribacterium
Barker.

Corynebacterium blattellae Gleser.
(Jour. Exp. Med., 51, 1930, 907.) Found
in the fat body of the German colrect
(Blattella germanica). For a more complete description see Manual, 5th ed.
1939, 978.

Corynebacterium bruneum Kisskalt and Berend. (Bacterium bruneum γ arborescens, quoted from Kisskalt and Berend, Cent. f. Bakt, I Abt, Orig, 81,1918,446; Kisskalt and Berend, idem)

Source not given.

Corynebacterium cerebralis Eberson (Jour. Inf. Dis, 23, 1918, 17.) From the brain in a case of meningitis

Corynchacterium ceruminis (Graham-Smith) Eberson. (Bacillus ceruminis Graham-Smith, Jour. Hyg., 4, 1901, 255; Eberson, Jour. Inf. Dis., 25, 1918, 8.) Indole is not formed. From normal and scarlet fever-infected ears. Corumbacterium commune Martin

(Compt. rend. Soc. Biol., Paris, 81, 1918, 991 and 998) From the pharynx

Corunebacterium cremoides (Lehmann and Neumann) Jensen. (Bactersum cremoides Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 253; Jensen, Proc Linn, Soc. New So. Wales, 59, 1934, 40 ) From tapwater, Wurzburg. Lehmann and Neumann recognize this species as a Corynebacterium in the seventh edition their determinative bacteriology (Bakt. Diag., 7 Aufl., 2, 1927, 710) but do not use the binomial Corynebacterium cremoides except in the index, page 848. Jensen has reisolated this organism from soil in Australia. Bacterium cocciforme Migula (Kultur No 2, Severia, Cent. f. Bakt., II Abt., 1, 1895, 160; Migula, Syst. d. Bakt., 2, 1900, 439) from manure is regarded by Jensen (loc. cit) as closely related to this species.

Corynebacterium eucyli (Graham-Smith) Bergoy et al (Bacillus eucyli Graham-Smith, Jour. of Hyg. 4, 1904, 315; Bergoy et al., Manual, 1st ed., 1923, 387) From the throat of a euckoo For a more complete description see Manual, 5th ed., 1939, 802.

Corynebacterium cuniculi Hauduroy et al. (Bacillus pyogenes cuniculi Commotti, Clinica Veterinaria, 44, 1921, 45, Hauduroy et al., Diet. d. Bact. Path., 1937, 147). Reported as Gram-variable by Cominotti, as Gram-negative by Hauduroy et al. Causative agent of suppurative infection of rabbit.

Corpuebacterum cutis Haudmoy et al. (Bacillus cutis communis Nicolle, quoted from Costa, Troisser and Dauvaugne, Compt. rend. Soc. Biol., Pars, 81, 1918, 1903; Bacillus cutis Costa, Troisser and Dauvaugne, ibid., 1904; Bacterium cutis commune Nicolle, quoted from Debré and Letulle, La Presse Méd., 27, 1919, 515; Hauduroy et al., Diet. d. Bact. Path., 1937, 148) From normal skin and nasal passages.

Coryncbacterium delicatum Eberson. (Jour. Inf Dis., 23, 1918, 16.) From ascitic fluid. Also from blood.

Coryachacterium dermophilum (Rohde) Andrewse et al. (Bacillus dermophilus Rohde, Munch. med. Wehnschr., 68, 1921, 234; Andrewes, Bulloch, Douglas, Dreyer, Fildes, Ledingham and Wolf, Diphtheria, London, H. M. Stationery Office, 1923, 391) From the skin

Corynebacterium diphiheroides Prévot. (Bacille diphiheroide, Jungano, Compt. rend Soc Biol., Paris, 61, 1909, 112; Prévot, Ann Inst. Past , 60, 1938, 304) Forms gas in some media. From the intestines of white rafs.

Corynebacterium epidermidis Eberson. (Jour. Inf Dis, 25, 1918, 17.) From skin and pus pockets. Resembles Corynebacterium suppuratum Eberson

Corynebacterium flocculens Eberson. (Jour Inf Dis, 23, 1918, 17.) From a case of appendicitis.

Corynchactersum gallinarum Bergey et al (Bacillus diphteroides gallinarum Graham-Smith, Jour of Hyg., 4, 1901, 314, Bergey et al., Manual, 1st ed., 1923, 387) From the throats of chickens For a more complete description see Manual, 5th ed., 1939, 502.

Corynebacterium glandulae Eberson. (Jour. Inf. Dis , 25, 1918, 14.) From lymph glands in Hodgkin's disease but not specific for the disease

Corynebacterium granulomatis maligni de Negri and Miercmet. (Cent f. Bakt, I Abt., Orig., 68, 1913, 292) Causative agent of human malignant granuloma. Corynebacterium granulosum Prévot. (Bacille granuleux, Jungano, Compt. rend. Soc. Biol., Paris, 66, 1909, 123; Prévot, Ann. Inst. Past., 60, 1938, 304.) From the intestines of white rats.

Coryncbacterium hepatodystrophicans (Kucsinski) Prévot. (Bacillus hepato-dystrophicans Kuczinski, Der Erreger des Gelbfiebers-Wesen und Wirkung, Monographie, 1929, Berlin; Prévot, Ann. Inst. Past., 60, 1938, 304.) Manteufel (Cent. f. Bakt., I Abt., Orig., 138, 1937, 309) regards this species as identical with Bacillus renale (cuniculi) Manteufel and Herzberg. Common in the organs of monkeys infected with vellow fever virus.

Corynebacterium hodgkınıi Bunting and Yates. (Bunting and Yates, Arch. Internal Med , 12, 1913, 236; Johns Hopkins Hosp. Bull., 25, 1914, 173; Bacillus hodgkini Mellon, Jour. Bact., 2, 1917, 271; Fusiformis hodgkini Holland, Jour. Bact., 5, 1920, 223 ) From lymph glands in Hodgkin's disease. Not pathogenic. Thought by Fox (Jour. Med. Res., 32, 1915, 309) and Eberson (Jour. Inf. Dis, 23, 1918, 11) not to represent a definite species Eberson recognized four separate species isolated from human lymph glands, three being from glands in Hodgkin's disease (Corynebacterium aurantiacum, C. pseudodiphtheriae, C. glandulae and C lymphophilum)

Corynebacterium liquefaciens Prévot. (Bacillus parvus liquefaciens Jungano, Compt rend Soc. Biol , Paris, 65, 1908, 618; Prévot, Ann. Inst. Past , 60, 1938, 304, not Corynebacterium liquefaciens Andrewes et al., Diphtheria, London, 1923, 408; not Corynebacterium liquefaciens Jensen, Proc. Linn. Soc. New So. Wales, 69, 1934, 49.) From human intestince

Corynebacterium liquesacens Andrewes et al (Bacillus diphtheroides liquesaciens Graham-Smith, Jour Hyg., 4, 1904, 258, Bacillus liquesacens Mellon, Jour-Bact, 2, 1917, 299; Andrewes, Bulloch, Douglas, Dreyer, Fildes, Ledingham, and Wolf, Diphtheria, London, 1923, 409.) From mouth of a nationt. Motile. Corynebacterium lymphae taccinclu Levy and Fickler. (Deutsch. med. Wchnschr., 28, 1900, 418; Corynebaterium pyogenes Lewandowsky, Cent. f. Bakt., I Abt., Orig., 38, 1904, 473.) From animal lymph.

Corynebacterium lymphophilum (Torrey) Eberson. (Bacillus lymphophilu Torrey, Jour. Med. Res., 34, 1916, 79; Eberson, Jour. Inf. Dis., 28, 1918, 23 Anaerobic. From lymph glands in Holgkin's disease, but not specific for the disease.

Corynebacterium maculatum (Graham-Smith) Ford. (Bacillus maculatus Graham-Smith, Jour. Hyg. 4, 1994, 285; Ford, Textb. Bact., 1927, 277.) From throat. Regarded as a Corynebacterum by Eberson (Jour. Inf. Dis., 25, 1915, 7).

Corynebacterium metritis Hauduny et al. (Souckin, Sovetskaia Veter, No II, 1934; Hauduroy et al., Diet. d. Bat. Path., 1937, 156.) Causative agent of metritis in rabbit.

metritis in radoit.

Corynebacterium millinum Kisskilt.

Quoted from Kisskalt and Berend,
Cent. f. Bakt., I Abt., Orig., 81, 1918,
446). Source not given.

Corynebacterium nodosum (Migub)
Eberson. (Bacillus nodosus perut
Lustgarten-Mannaberg, Viertelpir,
schrift f. Dermatol. u. Syphilis, ISS,
014; Bacterium nodosum Migula, Syxl-d,
Bakt., 2, 1900, 416; Eberson, Jour. Isl.
Dis., 23, 1018, 4.) Found in the normal

human urethra. Corynebacterium nubilum (Frankland and Frankland) Jensen. (Bacillus nu bilus Frankland and Frankland, Zischt. f. Hyg., 6, 1889, 386; Bacterium nubilum Lehmann and Neumann, Bakt. Diag. 1 Aufl., 2, 1896, 255; Chromobacterium nubile Ford, Textb. of Bact., 1927, 472, Flavobacterium nubilum, incorrectly ascribed to Bergey, by Jensen, Proc. Luna. Soc. New So. Wales, 59, 1934, 44; Jensen, idem.) From water and soil. The ideatity of this species is doubtful. The original description by the Franklands is incomplete. Zimmerman (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1,

coniem and described it as Gram-necotive Lehmann and Neumann (Bakt. Ding. 1 Aufl., 2, 1896, 255) who studied one of Zimmermenn's cultures reported this culture as Gram-positive and nonmotile, while the Franklands and Zimmermann speak of an active, circular motility of the very slender rods. Lehmann and Neumann later (Bakt, Diag., 7 Aufl., 2, 1927, 710) list their Bacterium nubilum (with other Gram-positive, nonmotule rods) as a possible Corunehocterium Jensen failed to find anything that exactly corresponded to any of these descriptions but describes a small. Gram-positive, poorly-growing, pink to red, slow gelatin houghving rod which he says has little in common with corvnehacteria as a new variety Corunebacterum nubilum yar, nanum. Because the early cultures developed rhizoid growths in stiff relatin before liquefaction. Zimmermann originally planned to call this species Bacillus nebulosus (loc. cit., 29). a name that has been used by later authors for several different organisms. Attention should be called also to Bacillus caudatus Wright, an organism which Conn found to show occasional motility (polar) and named Pseudomonas caudadatus This common, slender, relatinliquefying, Gram-negative, white to vellow chromogenic rod is much like the Franklands' and Zimmermann's organ-18m (see Conn, New York State Exp Sta Tech Bull, 67, 1919, 38).

1800 78) thought he found the same or-

Corpuscacterium paralyticans (Robertson) Ford (Bacillus paralyticans Robertson), Rev. Neurol. and Psychiat, Edinburgh, 1, 1903, 470; Ford, Tevtb. of Bact. 1927, 281.) From cerebrospinal fluid A diphtheroid Thought at one time to be the causal agent of general paralysis

Corynchacterium parrum Prévot. (Corynchacterium parrum infectiosum Mayer, Cent. f. Bakt, I Abt, Orig., 98, 1926, 370; Prévot, Man. de Class. et Déterm. des Bactéries Anaérobies, Monographie, Inst. Past., Paris, 1940, 202.) From blood in a post-natal fever.

Corynebacterium persplanetae Bergey et al. (Corynebacterium persplanetae var. americana Glaser, Jour. Exp. Med., 51, 1930, 50; Bergey et al., Manual, 4th ed., 1934, 550 ) Found in the fat body of the American cockroach (Persplaneta americana). For a more complete description see Manual, 5th ed, 1939, 793.

Corynebacterium plumosum (Fox)
Ford. (Mycobacterium plumosum Fox,
Cent. f. Batt. J. Abt., Orig., 70, 1913,
148; Ford, Textb. Bact., 1927, 281.)
From blood of patient with chronic endocarditis.

Corynebacterium pseudodiphtheriae Eberson. (Jour. Inf. Dis., 25, 1918, 14.) Hemoglobinophilic From tonsils.

Corynebacierium putidum Eberson. (Bacullus diphtheroides Inguelaciens Graham-Smith, Jour. Hyg., 4, 1904, 258; Eberson, Jour. Inf. Dis., 23, 1918, 16.) From mouth Cultures described by Graham-Smith liquefied gelatin and were sluggishly motile.

Corpnebacterum pyogenes boeis (Roux)
Prévot (Bacellus pyogenes boers Roux,
Cent f Bakt , I Abt., Orig, 34, 1905, 541;
Eubacterum pyogenes boens Prévot, Ann.
Inst. Past., 60, 1938, 293; Prévot, Man.
de Class, et Déterm. des Bactéries Anaérobies, Mongraphie, Inst. Past, Paris,
1940, 204.) Common in bovine suppurations. Said by Roux to be identical with
Bacillus pyogenes bous Kunnemann.
Prévot says it is probably identical with
the pyogenic Corpnebacterium of Lucet.
See Corpnebacterium poenes Elverson.

Corynebacterium renale cunteuli Prévot. (Bacterium renale and Bacterium renale (cuniculi) Manteufel and Hertberg, Cent. f Bakt, I Abt., Orig, 116, 1939, 296; Bacillus renale and Bacillus renale (cuniculi) Manteufel, ibid., 153, 1937, 206; Prévot, Ann. Inst. Past., 60, 1938, 304.) Gram-variable. Forms gas in some media. From rabbit kidneys.

Corynebacterium ruedigers (Mellon)

Ford. (Virulent pseudodiphtheria bacillus, Hamilton, Jour. Inf. Dis., 1, 1904, 711; Ruediger's bacillus, Mellon, Jour. Bact., 2, 1917, 285; Bacillus ruedigeri Mellon, ibid., 290; Ford, Textb. Bact., 1927, 274.) From throats of fatal cases of scarlatina.

Corynebacterium segmentosum Eberson. (Bacillus coryzae seamentosus Cautley, Rept Med. Officer of Health. Local Govt. Board, London, 1894-95, 455; Bacillus septus Benham, Brit, Med. Jour., 1, 1906, 1023; Eberson, Jour. Inf. Dis., 23, 1918, 17; Bacillus segmentosus Holland, Jour. Bact., 5, 1920, 220.) Rods of variable dimensions, mostly resembling Corynebacterium pseudodiphtheriticum Lehmann and Neumann, but occasionally resembling Corunebacterium diphtheriae Lehmann and Neumann. Thomson and Thomson (Ann. Pickett-Thomson Res. Lab , 2, 1926, 65) do not think Cautley's bacillus is recognizable. From nasal secretions

Corynebacterium squamosum Belenky and Popova (Cent. f. Bakt., IAbt., Orig., 118, 1930, 444.) From normal skin of calves and small-pox vaccine. Nonhemolytic

Corynebacterium striatum (Chester) Eberson. (Bacillus striatus flavus and Bacıllus striatus albus von Besser, Beitr. z path. Anat. u Path., 6, 1888, 349; Bacterium striatus flavus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 111: Bacterium striatum Chester, Man. Determ. Bact., 1901, 171, Bacillus flavidus Morse, Jour. Inf. Dis., 11, 1912, 281; Corynebacterium flavidum Holland, Jour. Bact , 5, 1920, 218; Eberson, Jour. Inf Dis . 23, 1918. 5.) Eberson (loc. cit., 7) states that Bacillus diphtheroides citreus Graham-Smith (Jour. Hyg., 4, 1904, 258) corresponds with the yellow variety of this species From nasal mucus. Resembles Corynebacterium segmentosum

Corynebacterium suis Hauduroy et al. (Le bacille pyogenes suis, Colın and Rossi, Revue gén. de Méd. vetér., 40, 1931, 137; Hauduroy et al., Dict. d. Bact. Path., 1937, 167). Causative agent of caseous suppuration of swine. Gramnegative.

Corynebacterium suppuratum Eberson. (Jour. Inf. Dis., 23, 1918, 17.) From anal pus pocket. Resembles Corynebacterium epidermidis Eberson.

Corynebacterium thermophilus Zavagh (Amer. Jour. Hyg., 15, 1932, 504.) From raw and pasteurized milk. Grows better at 55°C than at 37°C.

Corunebacterium typhi Topley and (Bacillus typhiexanthemalici Plotz, Jour. Amer. Med. Assoc., 62, 1913, 1556; La Presse Méd., 48, 1914, 411; Plotz, Olitsky and Bachr, Jour. Inf. Dis, 17, 1915, 17; not Bacillus typhi exanthematica Klebs, Proc. Internat. Med. Cong. 1, 1881, 323; Corynebacterium typhi-eranthematici Eberson, Jour. Inf. Dis, 25, 1918, 19; Bacterium typhi-exanthematici Holland, Jour. Bact., 5, 1920, 222; Fustformis typhi-exanthematici Holland, and, 221; Topley and Wilson, Prin. of Bact. and Immun., 2nd ed., 1936, 349; Eubaclerium typhi-exanthematici Prévot, Ann Inst. Past., 60, 1938, 295.) From blood of typhus fever patients.

Corynebacterium ulcerogenes Bengy et al. (Corynebacterium diphtheriae ucerogenes cutaneum Mrongovius, Cent. I. Bakt., I. Abt., Orig, 112, 1923, 51, Bergey et al., Manual, 4th ed., 1934, 53) From ulcerations of the skin (humah. Resembles Corynebacterium epidemitia Eberson and C. suppuratum Eberson.

Corynebacterium vaccinae Galli-Valerio (Cent. f. Bakt., I Abt., Orig., 56, 1904, 465.) From vaccine pustules in calves Corynebacterium zerosis canis

(Graham-Smith) Ford. (Bacillus zerosis canis Graham-Smith, Jour. Hys. 4, 1904, 258; Ford, Textb. Bact., 1927, 211) From conjunctival sacs of dogs

Corynethriz hominis, C. equi, C. cest, C. anatis, etc. Czaplewski. (Deutsche med. Wchnschr., 26, 1900, 723) Hypothetical species from the skin of the animals indicated.

Corynethrix pseudotuberculosis murium Bongert. (Ztschr. f. Hyg., 57, 1901, 472.) From a multiple, necrotic, caseous pacumonia of mice inoculated with
material from equine pneumonia. Regarded by the author as distinct from
Bacillus pseudotuberculosis murium
Kutscher. Placed in the genus Corynethriz Czaplewski (Deutsche med.
Wchnschr. & 1, 91000, 723)

Lactobacillus meleagradus Johnson and Pollard. (Diplo-bacillus P., Johnson sud Anderson, Jour. Inf. Dis., 58, 1936, 349, Johnson and Pollard, Jour. Inf. Dis., 68, 1940, 196.) From heart, Iver and yolk of moribund turkey poults. Presumably a Corynebacterium, not a true Lectobacillus.

Einer sporogenen Pseudo-Diphtheriebanllus, De Simoni (Cent. f. Bakt, I Abt, Orig, 24, 1898, 294) From nasal secretion in ozena. Produced spores only in milk and on potato Thought by Eberson (Jour. Inf. Dis., 25, 1918, 6) thave been a contaminated culture

Organism in M. H., De Witt. (Jour Inf. Dis., 10, 1912, 40.) A motile, gasproducing diphtheroid isolated from a generalized diphtheria-like infection.

Appendix III: The relationships of the following soil organism are not clear. but it apparently should be placed either in Corunebacterium or in a related genus (e g . Mucobacterium) On agar it is rodshaped and generally Gram-negative in young cultures, but coccoid and Grampositive in old cultures, a condition noted by Mellon (Jour Bact . 2, 1917. 278) in connection with Corunebacterium enzumicum Something similar is noted by Jensen (Proc. Linn Soc New So Wales, 59, 1934, 29-62) in his description of Corynebacterium helvolum Krassilmkov, on the other hand (Cent f Bakt , II Abt . 90, 1934, 432), suggests that this species really belongs to Mycobacterium, and, after seeing a culture furnished him by Conn, has become all the more convinced of this relationship (personal correspondence)

Krassilnikov's studies indicate that there is a group of soil bacteria that grow as rods in young cultures with a tendency to produce branching forms in liquid media and develop coccoid hadres as they grow older. The latter then even divide and multiply like cocci He considers that practically all so-colled micrococci found among soil cultures are really the older stages of Mucchacterium ann. It is very clear that Jensen and Krassilnikov, the two leading students of the saprophytic members of this group found in soil, do not agree as to what constitutes the genus Mucobacterium: their napers appeared almost simultaneously and clearly represent independent work. Krassilnikov's description of this genus comes closest to covering organisms like the following of any of the descriptions in the literature, but it is quite different from Jensen's idea of the reaus. In fact, the descriptions given by the former author seem to be more like Jensen's conception of the genus Corunebacterium Jensen, in his description, takes into account the relative acid-fast staining properties of the groups, but Krassilnikov does not mention either this property or the Gram stein Insamuch as the scid-fast property is regarded in the present classification as an important characteristic of Mucobacterium, the following species is included as an appendix, not of that genus, but of Corunebacterium. The relationships of these pleomorphic soil organisms must be regarded as decidedly obscure Lochhead (Can Jour Res. Sec C, 16, 1938, 156) speaks of a Bacterrum alabiforme group and Conn (Jour. Bact . 48, 1945, 359) has recently reported evidence in support of Lochhead's view-In all probability this group is noint identical in whole or in part with Krassilnikov's Mucobacterium of soil, although the correctness of his choice of this generic name may be questioned

<sup>\*</sup>Prepared by Prof. H J. Conn, New York State Experiment Station, Geneva, New York, July, 1945.

Bacterium globiforme Conn. (Conn, N. Y. Agr. Evp. Sta. Tech. Bull. 138, 1923 and 172, 1930; Cent. f. Bakt., II Abt., 76, 1928, 77; Achromobacter globiforme Bergey et al., Manual, 3rd ed., 1930, 226.) From Latin, having the form of a globe or sphere.

Short rods. 0.4 to 0.6 by 0.6 to 0 8 micron, becoming coccoid in older cultures. In certain liquid synthetic media, branching forms with Gram-positive spherical granules are common. These granules have a tendency to be acid-fast. Non-motile. Rods usually Gram-negative; occoid forms usually Gram-positive.

Gelatin colonies: Circular, punctiform. Gelatin stab: Slow crateriform liquefaction.

Agar colonies Circular, punctiform, translucent.

Agar slant: Filiform, flat, smooth, soft, translucent, glistening growth with translucent sheen.

Broth: Slight growth

Nitrites produced from nitrates in synthetic agar media.

Glucose, sucrose, mannitol, and less readily lactose and various organe acids are utilized as sources of carbon and energy when grown in synthetic medis No visible gas production, and probably no acid except carbonic acid

Nitrogen may be obtained from am monium sulfate, asparagine, cystine, glycerol, aspartic acid, uric acid, tyrosin, potassium nitrate, urea and peptone

Aerobic, facultative. Optimum temperature 22°C.

Source Seventy cultures isolated from soil.

Habitat: Widely distributed in soil

#### Genus II. Listeria Pirie.\*

(Listerella Pirie, Publ. So. African Inst. for Med. Res., 3, 1927, 163; not Listerella Jahn, Ber. d. deutsch. Bot. Ges., 24, 1906, 538; not Listerella Cushman, Contr. Cushman Lab. Foram, Sharon, Mass., 9, 1933, 32; Pirie, Science, 91, 1940, 333.) Named for Joseph Lister, the English surgeon and bacteriologist.

Small rods, Gram-positive. Flagellation peritrichous. Aerobic. Catalase positive. Grow freely on ordinary media. Acid but no gas from glucose and a few additional carbohydrates. Pathogenic parasites. Infection characterized by a mococytosis. Parasitic on warm-blooded animals.

The type species is Listeria monocytogenes (Murray et al.) Pirie.

 Listeria monocytogenes (Murray et al.) Pirie (Bacterium monocytogenes Murray, Webb and Swann, Jour. Path. and Bact., 29, 1926, 407; Listerella hepatolytica Pirie, Publ. S. African Inst. for Med. Res., 3, 1927, 164; Listerella monocytogenes Pirie, ibid.; Listerella monocytogenes hominis Nyfeldt, Folia Haematologica, 47, 1932; Corynebacterium parvulum Schultz, Terry, Brice and Gebhardt, Proc. Soc. Exp. Biol. Med., \$1, 1934, 1021; Pirie, Science, 91, 1940, 383; Bacillus monocytogenes Tobia, Arch. ital. med colon., 25, 1942, 219; abst. in Cent. f. Bakt., I Abt., Ref., 144, 1943, 199 ) Derived from the Greek, meaning generating monocytes.

Small rods: 0.4 to 0.5 by 0.5 to 20 microns, with rounded ends, slightly curved in some culture media Over singly, in V-shaped or parallel pairs sain in short chains. Motile, peritriches (Paterson, Jour. Path. and Bact., 48, 1939, 25) with four flagella at ordnary temperatures with tendency toward non-motility or single flagellum at 37°C (Griffin, Jour. Bact., 48, 1944, 114). Not acid-fast. Gram-positive

Gelatin: No liquefaction. Growth is confined to the needle track.

In 0 25 per cent agar, 8.0 per cent gelatin, 1.0 per cent glucose semisolid medium, growth along the stab in 24 hours at 37°C, followed by irregular cloudy or

Revised by Prof. E. G. D. Murray, McGill Univ., Montreal, P. Q., Canada, September, 1938; further revision, January, 1945.

granular extensions into the medium: growth does not spread through the entire medium. This is characteristic (Seastone, Jour. Exp. Med., 62, 1935. 2031

Sheep liver extract agar colonies. Circular, smooth, slightly flattened, transparent by transmitted and milk-white by reflected beht. Viscid.

Sheen liver extract agar slant Confluent, flat, transparent, viscid growth, Pentone agar; Growth is thinner than

on liver extract agar. Blood agar: Improved growth with

zone of hemolysis around colonies Pentone broth, Surface film with

flocculent sediment. Litmus milk: Slightly acid, decolor-

ized No coagulation Giveerol-rotato: No apparent growth Inspisanted ox serum : Grows as a very

thin, transparent film Dorret's eer medium: Very thin film

Indole not formed.

Hydrogen sulfide not farmed

Nitrites not produced from nitrates. Acid but no gas from glucose, thamnose

and saliein promptly, more slowly from dextrin, sucrose, soluble starch and glycerol Acid production may be variable and slow from maltose and lactose No action on arabinose, galactore, za lose, mannitol, dulcital, inulin and torsital.

All cultures give off a penetrating, rather unpleasant acid smell Ontimum temperature 37°C Ther

tembie, facultative

mal death point 55° to 57°C in 10 runutes Animal inequiations: Injection of rabbuts with cultures results in a very marked increase in respectes circulat ing in the blad. This is the most strikone character of the pression and is exhibited by strains derived from all sources defection is characterized by promitic fiel in satisfic organs.

Sent sical characters: Aggletination and always on of agglution resetions about a variation in degree with different steered at there is to defeite indicated that strains form different kinds of artmal hoste are different species. Paterson (Jour. Path. and Bact., 57, 1910. 427) concludes from his studies of the flagellar and somatic anticens of 54 cultures that four types may be recornized in this species. These do not bear any relation to the host species or to the geographical area from which they nem isolated.

Possibly related to Erusipelothriz (Barber, Jour. Path and Bact., 48. 1939, 11).

Habitat and source: Lesions in organs. blood, cerebrospinal fluid of rabbits. guinea pigs, sheep, cattle, foxes, hors, fowls, gerbilles and man, in all of which natural disease occurs. Many cases have proved fatal. The cause of infectious mononucleosis in man (Nyfeldt, loc cit.).

Appendix: The following binomials have also been proposed for species in this genus

Bacterium hepatis Hülphers (Syen. Vet Tidskrift, 2, 1911, 271.) From necrosis of the inter of a rabbit Nyfeldt (Skand Vet -Tidskrift, 20, 1910, 251) regarde this as a synonym of Litterella monocytogenes Honever, failure to ferment lactore, rhamnore, sucrore and salicin with fermentation of valore, and failure to infect guines pigs and chickensindicate a presible difference let acen the two apecies

Listerella hibiscus liquefaciens Nakahama. (Jour Agr Clem. See Japan. 16, 1910, 315) From retted Lenaf (Hilsteys)

Luterella borines, Luterella berna. Lieterella gillinarum, Lieterella came ila and Luterella cerbilli Wramby ("Lan I Vet Tidelinit, St. 1911, 2007 These narys are given to indicate cultures of Luterella reportionnes in man cattic, chickens, ratists and gerialics, merechnele

Luterella cen Gil (Australian Vet Jour, 15, 1937, 47 ) Cause circles. direm of strop

Ham (Jean Part , 27, 1923, 273) reports, but divers, t carro, a rem ejector in this group.

## Genus III. Erysipelothrix Rosenbach.\*

(Ztschr. f. Hyg., 63, 1909, 367.) From Greek erysipelas, a disease; and thriz, hair or thread.

Rod-shaped organisms with a tendency to the formation of long filaments. The filaments may also thicken and show characteristic granules. Non-motile. Grampositive. Microacrophilic. Catalase negative. Grow freely on ordinary meda. Acid but no gas from glucose and a few additional carbohydrates. Parasitic on mammals.

The type species is Erysipelothrix thusiopathiae (Migula) Winslow et al.

1. Erysipelothrix rhusiopathiae (Migula) Winslow et al. (Bacillus des Schweinerotlaufs, Loeffler, Arb. a. d. k. Gesundheitsamte, 1, 1886, 46; Bacillus thuillieri Trevisan, I generi e le specie delle Batteriacec, 1889, 13, Pasteurella thuillieri DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 995; Bacillus rhusiopathiae suis Kitt. Bakterienkunde u. path. Mikroscopie, 1893, 284; Bacterium erysipelatos suum (sic) Migula, in Engler and Prantl, Die naturl. Pflanzenfam., 1, 1a, 1895, 24; Bacterium rhusiopathiae suis Chester. Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 98; Bacterium rhusiopathiae Migula, Syst. d. Bakt., 2, 1900, 43; Mycobacterium rhusiopathiae Chester, Man Determ. Bact., 1901, 352; Erysipelothrix porci Rosenbach, Ztschr. f. Hyg, 63, 1909, 367; Winslow et al., Jour. Bact , δ, 1920, 198; Bacillus erysipelatos-suis Holland, Jour. Bact , 5, 1920, 218; Erysipelothrix erysipelatos-suis Holland, ibid. Bacillus ruboris suis Neveu-Lemaire, Précis Parasitol. Hum., 5th ed., 1921, 24; Nocardia thuilliers Vuillemin, Encyclopédie Mycologique, Paris, 2, 1931, 125; Actinomyces thuilliers Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 45.) From Greek rhusius, reddish; Tithus, a disease; red disease.

Description taken in part from Karlson, Jour. Bact., \$5, 1938, 205.

Slender rods: 0.2 to 0.3 by 0.5 to 1.5 microns, occurring singly and in chains. Non-motile. Gram-positive.

Gelatin colonies: Hazy, bluish-gray,

racemose; situated a little below the surface, growing slowly.

Gelatin stab: Small, fimbriate colonies in the stab, at times definitely arborescent. No surface growth. No hque-

faction.

Agar slant: Scant growth, translucent,

moist, homogeneous.

Broth: Slight turbidity, with scant,

grayish sediment.

Litmus milk: May become slightly acid.

Indole not formed.

Potato: Usually no growth.

Blood serum shows scant growth.
No gas from carbohydrates. Acid
from glucose, galactose, fructose, lactose

from gueose, galactes, rucas and more slowly from mannose and cellbiose. No acid from arabinose, xylos, rhamnose, maltose, melibiose, sucres, trehalose, raffinose, melezitose, dextm, starch, inulin, anygdalin, glycerol, crythritol, adonitol, manitol, sorbitol, dulcitol or inositol.

Esculin not hydrolyzed.

Hydrogen sulfide produced. Voges-Proskauer test negative.

Methyl red test negative. Methylene blue-reduction test nega-

Narrow green zone of hemolysis develops around deep colonies on blood

agar. Catalase negative.

Out of 43 strains studied serologically (Watts, Jour. Path. and Bact., 50, 1940, 355), 38 appeared to be of one antigenic group, and 5 of another.

<sup>\*</sup> Revised by Prof. Robert S. Breed, New York State Experiment Station, August, 1933; further revision, January, 1945.



# FAMILY IX. ACHROMOBACTERIACEAE BREED.

(Jour. Bact., 50, 1945, 124.)

Rods, small to medium in size, cells usually uniform in shape. No branching on ordinary media, if at all. Gram-negative, rarely Gram-variable. Peritrichous or nontle. Growth on agar slants non-chromogenic to grayish-yellow, brownish-yellow or yellow to orange. The pigment does not diffuse through the agar. Characterized by lack of power or feeble powers of attacking carbohydrates. May form acid free hexoses but no gas. May or may not reduce nitrates. May or may not liquefy gelstu Do not liquefy agar or attack cellulose, and are not phosphorescent. Litmus mik may become faintly acid but not sufficiently acid to curdle. Usually the restina remains unchanged or becomes alkaline. Generally salt water, fresh water and soil forms and, less commonly, parasites. Some plant pathogons may belong here

### Key to the genera of family Achromobacteriaceae.

Non-chromogenic or at most little or no chromogenesis on agar or gelatin meda
 A. Litmus milk turned alkaline. No acid from carbohydrates.

### Genus I. Alcaligenes, p. 412.

B. Litmus milk slightly acid (never curdled), unchanged or alkaline. Acid usually produced from hexose sugars.

# Genus II. Achromobacter, p. 417.

- Produces yellow to orange chromogenesis.
  - A Litmus milk slightly acid (never curdled) unchanged or alkaline Acid usually produced from hexose sugars.

### Genus III. Flavobacterium, p. 427.

Genus I. Alcaligenes Castellani and Chalmers.\*

(Manual Trop Med., 3rd ed., 1919, 936.) From M.L., alkalı and Latin genie, to

Peritrichous to monotrichous, or non-motile rods. Gram-negative to Gamvariable. Do not produce acid or gas from carbohydrates. May or may not lquest gelatin and solidified blood serum. Turn litmus milk alkaline and may or may not peptonize it Do not form acetylmethylcarbinol. Chromogenesis when it occurs is grayish-yellow, brownish-yellow or yellow. Generally occur in the intestinal tract of vertebrates or in dairy products.

The type species is Alcaligenes faecalis Castellani and Chalmers.

<sup>\*</sup>Revised by Prof H. J. Conn, New York State Experiment Station, General New York, June, 1938; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, June, 1945.

### Ken to the species of genus Alcaligenes.

- I. Gelatin not liquefied.
  - A. Motile.
    - 1. Does not produce ropiness in milk. Found in the intestinal tract.
    - 1. Alcaligenes faecalis.
      2. Produces repiness in mulk

    - B. Non-motile.
- Alcaligenes viscosus.
  - 3 Alcaligenes metalcaligenes.

- II Gelatin liquefied.
  - A Motile.
    - 1. Milk peptonized; blood serum liquefied.
    - 4 Alcaligenes booleri.
      2 Milk not peptonized, blood serum not liquefied.
  - R Non motile
    - I Milk peptonized, slimy
- 6. Alcaligenes marshallis.

5 Alcalenanas rosti

- 1 Alcaligenes faecalis Castellani and Chalmers (Bacillus faecalis alcaligenes Petruschky, Cent f Bakt . I Abt . 19. 1896. 187: Bacterium fecalis alcaliaenes Chester, Ann Rent Del Col Agr Exp. Sta., 9, 1897, 73: Bacterium alcaligenes Lehmann and Neumann. Bakt Diag . 2 Aufl . 1899. 242: Bacillus alcaliaencs Migula, Syst. d. Bakt., 2, 1900, 737. Castellani and Chalmers, Manual Trop Med., 1919, 936; Bacillus fecalis-alcaliacnes Holland, Jour. Bact . 5, 1920, 218, Bacterium fecalis-alcaligenes Holland. ibid : Vibrio alcaligenes Lehmann and Neumann, Bakt. Diag., 7 Aufl , 2, 1927, 548 Bacterium faecale alcaligenes Monias, Jour Inf. Dis . 45, 1928, 330.) From Latin facz, drees: M. L. fecal
- Rods 0.5 by 10 to 20 merons, occurrung singly and in pairs, and occasionally in long chains. Motile with peritrichous flagells. In some strains, the majority of the individual cells show only a single flagellum. This is apt to be in a lateral rather than in the polar position. Gramnegative

Gelatin colonies. Circular, grayish, translucent.

Gelatin stab: Gray surface growth. No liquefaction.

Agar colonies: Transparent with opaque center, undulate margin. Agar slant: White, glistening, onales-

Agar slant: White, glistening, opalescent, undulate margin

Broth Turbid, with thin pellicle, and viscid sediment. Gives off ammonia Latmus milk Alkaline.

Potato: Scanty to abundant, yellowish

Indole not formed

Nitrate production from matrates variable

No acid or gas from carbohydrate media

No characteristic odor

Aerobic, facultative. Ontimum temperature 37°C

Source Feces, abscesses related to intestinal tract, occasionally blood

stream
Habitat: Intestinal canal Generally

Habitat: Intestinal canal Generally considered non pathogenic

1s. Alcaligenes faecalis var radicans Evans (Public Health Rpts., 40, 1931, 1676) is a gelatin liquefying strain

2. Alcaligenes viscosus (Weldin and Levine) Weldin. (Bacillus lactis viscosus Adametz, Cent f. Bakt., 9, 1891, 698; Bacillus viscosus lactis Kruse, in Flugge, Die Mikroorganismen, 2, 1896, 359; Bacterium viscosus lactis Chester, Delaware Agr. Evp Sta. 9th Ann. Rept., 1897, 89; Bacterium lactis viscosum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 198 (Eng. ed , 1901, 196); Bacterium subviscosum Migula, Syst. d Bakt., 2, 1900, 326; Group I, varieties 1, 2, 3, 4 and 5 of Harrison, Rev Gén du Lait, 5, 1905, 100; Bacterium visco-coccoidium Buchanan and Hammer, Iowa Agr. Exp. Stat. Research Bull. 22, 1915, 260; Bacillus lactisviscosus Holland, Jour. Bact., 5, 1920, 218; Bacterium lactis-viscosus Holland, idem; Bacterium viscosum Weldın and Levine, Abst. Bact , 7, 1923, 16 (not Bacterium viscosum Migula, Syst d. Bakt., 2, 1900, 647), Lactobacillus viscosus Bergey et al , Manual, 1st ed , 1923, 244; Achromobacter viscosum Bergey et al , Manual, 2nd ed., 1925, 169; Weldin, Iowa State College Jour. Sci , 1, 1927, 186 ) From Latin viscosus, viscous.

Description taken largely from Long and Hammer, Iowa State Coll. Jour. of Sei , 10, 1936, 262.

Rods 06 to 10 by 08 to 2.6 microns, almost spherical cells frequently found. occurring singly, in pairs or short chains. Motile (Adametz, loc. cit), non-motile (Long and Hammer, loc. cit.). Gramnegative, rarely Gram-positive Capsules produced in milk cultures

Gelatin colonies Small, gray becoming vellowish

Gelatin stab White surface growth with villous growth in stab. No liquefaction.

Agar colonies. After 3 to 4 days, circular, 4 to 6 mm in diameter, white, viscid, shining, edge entire.

Agar slant · Abundant, white, spreading, viscid, shining

Broth: Turbid with thin pellicle and some sediment Ropiness generally produced.

Litmus milk : Ropiness produced. Pellicle formed. Alkaline. No coagulation Potato: Moderately heavy, dirty-white, spreading, shining growth.

Indole not formed.

Nitrites ordinarily not produced or produced only in a trace from nitrates No H2S produced.

Slight, if any, acid production from carbohydrates.

Fat is hydrolyzed.

Methyl red reaction negative

Voges-Proskauer reaction negative. Temperature relations: Growth occurs at 10° and at 20°C. At 37° and at 40°C

growth variable.

Aerobic

Source: Originally isolated from water Habitat: Found in water and around dairy barns, dairy utensils. Produces ropiness in milk.

Long and Hammer (Iowa State Coll Jour. Sci., 10, 1936, 264) have described a variety of this species (Alcaligenes viscosus var. dissimilis) which does not produce ropiness in milk.

3. Alcaligenes metalcaligenes Castellani and Chalmers. (Castellani and Chalmers, Man. Trop. Med., 1919, 936; Bacterium metalcaligenes Weldin and Levine, Abst. Bact., 7, 1923, 13; Achromobacter metalcaligenes Bergey et al, Manual, 2nd ed., 1925, 169.) From Greek meta, in common with; M. L. resembling alcaligenes.

Rods . 0.6 by 1.5 microns, with rounded ends, occurring singly and in pairs. Nonmotile. Gram-negative.

Gelatin stab: No liquefaction.

Agar colonies: Circular, raised, smooth, amorphous, entire, gray.

Agar slant : Gray, scanty, filiform, contoured, viscid.

Broth: Membranous pellicle with heavy sediment.

Litmus milk: Alkaline.

Potato: Scanty, glistening, smooth, sometimes faint pink.

Indole not formed.

Nitrite production from nitrates variable.

Starch not hydrolyzed. Blood serum not liquefied.

No action on carbohydrates.

Aerobic, facultative

Optimum temperature 22°C

Habitat · Intestinal canal

4. Alcaligenes bookeri (Ford) Bergey et al (Bacillus A of Booker, Trans Ninth Internat. Med. Congress, 3, 1887. 598, Bacillus bookers Ford, Studies from the Royal Victoria Hospital, Montreal, 1. 1903, 31; Bergey et al , Manual, 1st ed , 1923, 236, Bacterium booker: Levine and Soppeland, Eng Exp Sta , Iowa State College, Bul. 77, 1926, 55 ) Named for the bacteriologist who first isolated this species

Rods. 0 5 by 1.5 to 2 0 microns, occurring singly Motile with peritrichous flagella. Gram-negative

Gelatin colonies: Circular, brown,

variable in size Gelatin stab. Slow, saccate liquefac-

tion, becoming stratiform Agar colonies . Thin, transparent, with opaque center and indistinct margin

Agar slant . Abundant, yellowish to yellowish-brown

Broth Turbid, with viscid sediment No pellicle.

Litmus milk: Alkaline. Soft curd Litmus reduced Peptonization Luxurant, vellowish-white, Potato

moist Medium is darkened

Indole not formed

Natrites not produced from nitrates No acid or gas from carbohydrate media

Blood serum Yellowish-brown growth Gradual liquefaction

No characteristic odor

Aerobic, facultative.

Optimum temperature 37°C Source: From alvine discharges of chil-

dren suffering with cholers infantum

Habitat · Intestinal canal.

5. Alcaligenes recti (Ford) Bergev et al. (Bacterium recti Ford, Studies from the Royal Victoria Hospital, Montreal, 1, 1903, 31; Bergey et al , Manual, 1st ed., 1923, 236 ) From Latin rectus, rectum

Rods: 0.5 by 1.5 to 2.0 microns, occurring singly, in pairs and in chains. Motile with peritrichous flagella Gramnecative.

Gelatin colonies Variable in size and shape, circular to oval, brown.

Gelatin stab: Rapid, saccate liquefac-

Agar colonies. Large, gravish-white. with opaque center. Slightly spreading Agar slant Grayish-white, echinulate.

Broth . Turbid No pellicle. Litmus milk Alkaline. No peptoniza-

Potato Luxuriant, moist, brownish-

red.

Indole not formed Nitrates produced from natrates.

No acid or gas from carbohydrate media. Blood serum Abundant white growth. No liquefaction

No characteristic odor

Aerobic, facultative. Optimum temperature 37°C

Source Found but once from coecum and rectum (Ford).

Habitat Intestinal canal

6 Alcaligenes marshallil Bergey et al (Bacillus B of Marshall, Cent f Bakt., II Abt , 11, 1903, 739, Bacterium lactis marshall: Conn. Esten and Stocking, Ann. Rept Storrs Agr Exp Station, 1906, 141, Bergev et al , Manual, 1st ed , 1923, 237 ) Named for Prof. C. E. Marshall, the American bacteriologist who first isolated this species

Rods 03 by 12 microns, occurring singly. Non-motile Gram-negative

Gelatin colonies Gray, granular, irregular, glistening

Gelatin stab Slow, infundibuliform Inquefaction

Agar slant Filiform, gray to creamy. white, raised, becoming lemon-vellow.

Broth: Turbid, with gray ring and viscid sediment.

Litmus milk: Alkalinė, slimy, peptonized, strong odor.

Potato: Luxuriant, lemon-yellow,

Indole not formed.

Nitrites not produced from nitrates. No acid or gas from carbobydrates. Aerobic, facultative.

Optimum temperature 30°C.

Habitat: Milk.

Appendix: The following species have also sometimes been regarded as belonging in the genus Alcaligenes, or possess characters that indicate that they belong in this genus.

Ackromobacter alealiaromaticum (Berlin) Bergey et al. (Bacterium alealiaromaticum Berlin, Rev. de Microbiol. et Epidemiol., 6, 1927; Bergey et al., Manual, 3rd ed., 1930, 212.) From feces. See Manual, 5th ed., 1939, 509 for a description of this species This species is much like Alealaenes facealis

Ackromobacter cystinororum Barber and Burrows. (Buochem. Jour, 30, 1936, 599) From soil See Manual, 5th ed., 1939, 516 for a description of this species. Thus species is much like Alcaligenes marshalli.

Achromobacter lipidis (Anderson) Allison, Anderson and Cole. (Bacter-tum lipidis Anderson, Internat. Assoc. Milk Dealers, Proc. 30th Ann. Convention, Labora ory Section, October, 1937, 19; Allison, Anderson and Cole, Jour. Bact, 58, 1938, 571.) From rancial cream. See Manual, 5th ed., 1934, 521 for a description of this species I This species is much like Alcaligenes metal-caligenes.

Alcaligenes albus Bergey et al. (Bacterum lactis album Conn. Esten, and Stocking, Ann. Rept, Storrs Agr. Exp Station, 1903, 143; Bergey et al., Manual, 1st ed., 1923, 237.) From udder of cow. Gram-positive. See Manual, 5th ed., 1939, 100 for a description of this species.

Alcaligenes alcalinofoetidus Hauduroy et al. (Bacillus alcalinofoetidus Castellani, Jour. Trop. Med., 1930, 134; Hauduroy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire des bactéries pathogènes. Paris, 1937, 29.) From tonsils of persons having an offensive breath.

Alcaligenes ammoniagenes (Cooke and Keith) Bergey et al. (Bacterium ammoniagenes Cooke and Keith, Jour. Bat, 13, 1927, 315; Bergey et al., Manual, 37 ed., 1930, 367.) From feces of infants. Gram-positive. See Manual, 5th ed., 1939, 99 for a description of this species.

Alcaligenes denieri Corbet. (Oppaism No. 6, Denier and Vernet, Le Cœutchoue, 17, 1920, 10193; Quart. Jour Rubber Research Inst., Malays, 2, 1939, 182). From the latex of Herea brantiests (para rubber tree). Gram-positive. See Manual, 5th ed., 1939, 99, for a description of this species.

Alcaligenes faecalis var mariense Hauduroy et al. (Bacillus mariense Klimenko quoted from Besson, Technique Merobiologique, p. 904; Hauduroy et al., Dict. Path. Bact., Paris. 1937, 31.) A hydro-

Path. Bact., Paris, 1937, 31.) A hydrogen sulfide producing variety.

Alcaligenes lenis De Assis. (Boletim do Inst. Vital Brasil, Niteroi, No 13, 1930, 1.) From human blood stream. Alcaligenes sterensae Brown. (Amer

Museum Novit., No. 251, 1927, 6.)
From crushed egg masses of the moth
(Malacosoma americana). Said to be
related to Alcaligenes bronchisepticus

Bacillus coeci Ford. (Ford, Studies from Royal Victoria Hosp, Montreal, f., No. 5, 1903, 45.) Found in stomach and rectum of a single human subject. Much like Alcaligenes bookeri.

Bacillus pylori Ford. (Ford, Studies from Royal Victoria Hosp, Montreal I, No. 5, 1903, 44.) Found in the human stomach. Liquefied gelatin and peptonized casein but did not liquefy blood

serum.
Flavobacterium fecale Bergey et al.
(Bacillus fecale aromaticum Stutter,
Cent. f. Bakt., I Abt., Orig, 91, 1923, 57
Bergey et al., Manual, 3rd ed., 1930, 180)
From feces. Resembles Alcoisenes marshalfur. See Manual, 5th ed., 1939, 55
for a description of this species.

### Genus II. Achromobacter Bergey et al.\*

(Bergey et al., Manual, 1st ed., 1923, 132; Achromobacterium Richards, Proc. Soc. Agr. Bact. (British), 15th Ann. Conf., 1944, 14.) From Greek achroma, without color and bactrum, a staff or rod

Non-pigment-forming (at most no pigment formed on agar or gelatin) rods. Motile with pertiribous figgells or non-motile. Gram-negative to Gram-variable. Litmus milk faintly acid to unchanged or alkaline. Occur in salt to fresh water and in soil.

The type species is Achromobacter liquefaciens (Eisenberg) Bergey et al.

# Key to the species of genus Achromobacter.

# I. Motile, Flagella peritrichous

- A. Gelatin liquefied
  - 1. Litmus milk unchanged.
    - a. Nitrites not produced from nitrates.
      - 1. Achromobacter liquefaciens.
    - aa. Nitrites are produced from nitrates.
      - 2. Achromobacter thalassius,
      - 3. Achromobacter 10phanum.
  - 2. Litmus milk acid.
    - a Nitrites are produced from nitrates.
      - 4 Achromohacter delicatulum

#### B. Gelatin not liquefied

- 1. Litmus milk unchanged.
  - a. Nitrites are produced from nitrates.
    - 5. Achromobacter aquamarınus.
      - 6. Achromobacter cucloclastes.
- 2. Litmus milk slightly acid
  - a. Nitrites not produced from nitrates.
    - 7. Achromobacter superficiale.

### II. Non-motile.

- A. Gelatin liquefied
  - 1. Litmus milk unchanged
    - a. Nitrites slowly produced from nitrates
      - 8 Achromobacter stenohalis.
      - aa. Nitrites not produced from nitrates.
        - 9. Achromobacter buturi.
    - 2. Litmus milk alkaline
      - a Nitrites are produced from nitrates
        - 10 Achromobacter stationss.
- B. Gelatin not liquefied.
  - 1. Litmus milk unchanged.
    - a. Action on nitrates not recorded
    - 11 Achromobacter eurydice.
  - 2. Latmus milk seid, reduced in 5 days.
    - a Nitrites are produced from nitrates.

      12 Achromobacter delmarrae.

Partially rearranged before his death by Prof. D. H. Bergey, Philadelphia, Pennsylvana, September, 1937, further revision by Prof. Robert S. Breed, New York State Experiment Staton, Geneva, New York, August, 1945.

1. Achromobacter liquefaciens (Eisenberg) Bergey et al. (Bacillus liquefaciens Eisenberg, Baht. Diag., 3Aufi, 1891, 112; not Bacillus liquefaciens Doyen, Jour. d. connaiss. médic., 1889, 108; not Bacillus liquefaciens Lucet, Ann. Inst. Past., 7, 1893, 327; not Bacillus liquefaciens Lucet, Ann. Inst. Past., 7, 1893, 327; not Bacillus liquefaciens Migula, Syst. d. Bakt., 2, 1900, 723; Bacillus sternbergii Migula, Syst. d. Bakt., 2, 1900, 726; Bergey et al., Manual, 1st ed., 1923, 135.) From Latin, liquefying.

Description emended by Bergey et al. (loc. cit.). This is reported to be a common water organism by Lustig (Diag d. Bakt. des Wassers, 1833, 86), by Frankland and Frankland (Microorganisms in Water, 1894, 461) and by Horrocks (Bact. Evam. of Water, 1901, 54).

Short, rather thick rods, with rounded ends, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies: Circular, gray, entire, slimy. Liquefaction. In time a putrid odor.

Gelatin stab: Napiform liquefaction.
Agar slant: Dirty-white, spreading growth.

Broth: Turbid.

Litmus milk: Unchanged.

Potato: Light yellow streak.

Indole not formed.

Nitrates not produced from natrates. Aerobic, facultative

Optimum temperature 20° to 25°C. Habitat: Water.

2. Achromohacter thalassius ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Calif.,  $\delta$ , 1944, 279.) From Greek thalassius, marine, of the sca

Rods: 0 6 to 0.7 by 0 8 to 2.3 microns, with some variation in shape, occurring singly, in pairs and short chains and many cells lying side by side. Motile by means of peritrichous flagella. Gram-negative but cell walls tend to retain stain.

All media except the fresh-water broth,

litmus milk, and potato were prepared with sea water.

Gelatin colonies: 1 mm, circular, white.

Gelatin stab; Napiform liquefaction. Filiform growth along line of stab.

Agar colonies: Punctiform, rough, translucent. raised.

Agar slant: Moderate, glistening, beaded, watery, butyrous growth with no pigment.

Sea-water broth: No pellicle, slight

turbidity, scanty powdery sediment.

Fresh-water broth: Fair growth.

Litmus milk: No visible change. Casein not digested.

Potato: No visible growth.

Indole not formed.

Nitrites are produced from nitrates.

Does not ferment glucose, lactose, mal-

tose, sucrose, xylose, mannitol, glycerol, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but
not from urea.

Fats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C Source: Marine bottom deposits.

 Achromobacter iophagum (Gray and Thornton) Bergey et al. (Bacterium rophagum Gray and Thornton, Cent if. Bakt., II Abt., 73, 1923, 89; Bergey et al., Manual, 3rd ed., 1930, 201). From Greek ius, a poison and phagein, to est or devour.

Rods: 0.8 to 1.0 by 10 to 5.0 microns. Mottle by means of peritrichous flagells.

Gram-negative. Gelatin colonies: Quickly liquefied

Gelatin colonies: Quickly inquener Gelatin stab: Liquefied.

Agar colonies: Circular or amochoid, whitish, flat, raised, smooth, translucent, entire.

Agar slant . Filiform, white to buff, flat, undulate.

Broth: Turbid.

Litmus milk: Unchanged.

Nitrites produced from nitrates

Acid from glucose and sucrose. Occasionally from maltose and glycerol Attacks phenol and prohthalene

Aerobic, facultative
Optimum temperature 30° to 35°C
Source: Fifteen cultures from soil
Hebitet: Soil

Achromobacter delicatulum (Jordan) Bergey et al. (Bazellus delicatulus Jordan, Report Mass. State Bd of Health, 1890, 837, Bacterium delicatulus Chester, Ann. Rept. Del. Col Agr Evp Sta., 9, 1897, 82; Bergey et al., Manual, 1sted, 1923, 1377. From Latin delicatus, soft, delicate; M. L. delicatulus, somewhat delicate.

Characters added to Jordan's description by Bergey (loc. cit.) from his private notes are indicated. Steinhaus (Jour-Bact., 42, 1941, 771) apparently found the same organism and has added other characters.

Rods: 10 by 20 microns, occurring singly (Jordan). Motile, possessing peritrichous flagella. Gram-negative (Bergov).

Gelatin colonies. Whitish, homogene-

Gelatin stab Infundibuliform lique-

Agar slant: Whitish, glistening. Broth: Turbid, with gray pellicle and

sediment.
Litmus milk Acid. Slow reduction

and peptonization (Steinhaus)
Potato: Thin, gray streak

Acid from glucose, sucrose, maltose and lactose (slow) (Steinhaus).

No hydrolysis of starch (Steinhaus). No H<sub>2</sub>S produced (Steinhaus)

Indole not formed (Bergey). Nitrites produced from nitrates.

Aerobic, facultative.

Optimum temperature 30° to 35°C.

Source: From the effluent of a septic tank (Jordan). From water (Bergey) From the alimentary tract of an adult Colorado potato beetle (Leptinolarsa decembrate Say) (Steinbare)

Habitat: Presumably widely distributed in nature.

5 Achromobacter aquamarinus ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., δ, 1944, 264.) From Latin aqua, water, and marinus, saga.

Rods 08 by 1.2 to 20 microns, with rounded ends, occurring singly. Motile by means of a few peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litinus milk, and potato were prepared with sea water

Gelatin colonies. 2 mm, convex, circular, entire, whitish.

Gelatin stab Poor growth, no liquefaction, no pigment.

Agar colonies: 2 mm, convex, smooth, circular

Agar slant: Moderate, beaded, glistening, butyrous growth with no pigment.

Sea-mater broth. Surface ring, moderate turbidity, heavy viscous sediment. Fresh-water broth: Poor growth.

Litmus milk. No visible change. Casein not digested

Potato. No visible growth.

Nitrates rapidly produced from nitrates.

Produces acid but no gas from glucose and maltose Does not ferment lactose, sucrose, mannitel, glycerol, xylose, or salicin

Starch not hydrolyzed

Hydrogen sulfide not formed Ammonia produced from peptone but not from urea.

Fats are hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found in sea water and on sub-

Source: Found in sea water and on a merged alides.

Habitat: Sea water.

6. Achromobacter cycloclastes (Gray and Thornton) Bergey et al. (Bacterium cycloclastes Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 89; Bergey et al., Manual, 3rd ed., 1930, 212.) From Greek cyclus, ring and clastus, breaking in pieces.

Rods: 1.0 to 1.5 by 1.5 to 8.0 microns. Motile with 1 to 12 peritrichous flagella.

Gram-negative.

Gelatin colonies: Circular, white, raised, smooth, glistening, entire.

Gelatin stab. No liquefaction. Nail head growth.

Agar colonies: Circular to amoeboid, white, flat to convex, smooth, glistening, translucent with opaque center, entire. Agar slant: Filiform, pale buff, raised.

smooth, glistening, undulate.

Broth: Turbid.

Nitrites produced from nitrates.

Starch not hydrolyzed.

Litmus milk unchanged.

No acid from carbohydrate media.

Attacks phenol and naphthalene.

Aerobic, facultative.

Optimum temperature 30° to 35°C.

Source: Three cultures from soil. Habitat: Soil.

7. Achromobacter superficiale (Jordan) Bergey et al. (Bacillus superficialis Jordan, Report Mass. State Bd. of Health, 1890, 833; Bacterium superficialis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 94; Bergey et al., Manual, 1st ed., 1923, 144). From Latin superficialis, lying on the surface.

Characters added to Jordan's description by Bergey (loc. cit.) from his private

notes are indicated.

Rods: 1.0 by 2.2 microns, occurring singly (Jordan). Motile, possessing peritrichous flagella. Gram-negative (Bergey).

Gelatin colonies · Small, circular, gray, translucent

Gelatin stab: Scanty surface growth. Slow liquefaction.

Agar slant: Limited, gray, filiform. Broth: Slightly turbid. Litmus milk: No change. Later becoming slightly acid.

Potato: No growth (Jordan). Limited growth (Bergey). Abundant (Steinhaus).

Indole not formed (Bergey).

Nitrites not produced from nitrates.

Acrobic, facultative.

Optimum temperature 25° to 30°C.

Source: Sowage. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1934, 270) reports this species as occurring in the slime and feces of the cod (Gadus callarius) and dogfish (Squalus acanthias). An organism apparently identical with this organism has been found by Steinhaus (Jour. Bact., 42, 1944, 771) in the intestines of beetle larvae (Urographus fasciata DeG.).

Habitat: Presumably widely distributed in nature.

8. Achromobacter stenohalis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calit, 6, 1944, 257.) From Greek stenus, narrow or close, and halinus, salty; adapted to a slight change of salinity only.

Rods: 0 8 to 0.9 by 0.8 to 1.6 microns, occurring singly, in pairs and short chains. Non-motile. Capsulated. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: 1 mm, whitish, circular, convex, entire. No pigment.

Gelatin stab Very slow crateriform liquefaction. Napiform in 50 days.

Agar colonies: Small, circular, opalescent, lobate edge, convex with slightly

raised margin, smooth.

Agar slant: Moderate, beaded, glistening, opalescent, beaded growth with no pigment.

No pigment.

Sea-water broth: Moderate turbidity, viscid sediment, no pellicle or ring.

Fresh-water broth: No visible growth
Litmus milk: No visible change
Casein not digested.

Potato: No visible growth.

Indole not produced.

Nitrites slowly produced from nitrates No acid or gas from glucose, lactose, maltose, sucrose, mannitol, glycerol, xylose, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide not produced. Ammonia produced from peptone but not from urea.

Fats are not hydrolyzed.

Aerobic, facultative (poor anaerobic growth)

Optimum temperature 20° to 25°C Source. Sea water, marine mud, and marine phytoplankton.

Habitat: Sea water

Achromobacter butyri Bergey et (Micrococcus buturi-aromafaciens Keith, The Technology Quarterly, 10, 1897, 247; Bacillus butyri aromafaciens Grimm, Cent. f. Bakt, II Abt, 8, 1902, 589; Bergey et al , Manual. 1st ed . 1923, 148; Bacterium butyriaromafaciens Omeliansky, Jour. Bact., 8, 1923, 400) From Latin buturum, butter

Rods: 0 5 to 1 0 micron, nearly spherical, occurring singly and in pairs Non-

motile. Gram-negative Gelatin colonies White. circular. smooth, glistening,

Gelatin stab: White surface growth, liquefaction with white sediment

Agar slant · Abundant, white, glisten-

Broth: Turbid, with ring and sediment.

Litmus milk: Reaction unchanged

Aromatic odor. Potato: Slow and limited, white

growth. Nitrites not produced from nitrates.

Aerobic, facultative-Optimum temperature 25°C.

Habitat . Milk.

10 Achromobacter stationis ZoBell and Upham. (Bull. Scripps Inst. of Occanography, Univ. Calif , 5, 1911, 273 ) From Latin statio, anchorage.

Ovoid rods: 0.4 by 0.5 to 0.6 microns. occurring singly or in chains of two to three Non-motile. Gram-positive but easily destained.

All media except the fresh-water broth. litmus milk, and potato were prepared with sea water.

Gelatin colonies: 0 5 to 1 mm, circular, convey, grayish-white.

Gelatin stab: Very slow papiform liquefaction.

Agar colonies: 1 to 2 mm, convex, lobate edge, smooth, colorless,

Agar slant: Moderate, glistening, filiform, butyrous growth with no pigment. Sea-water broth Heavy pellicle, no

turbidity, granular growth along walls, scanty sediment Fresh-water broth Good growth.

Litmus milk: Becomes

Casein not directed. Potato: No visible growth.

Indole not formed.

Nitrites rapidly produced from ni-

trates. Produces acid but no gas from glucose.

Does not ferment lactose, maltose, sucrose, mannitol, glycerol, xylose, or salicın.

Starch not hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Fats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found in film of marine fouling organisms.

Habitat: Sea water.

11. Achromobacter eurydice (White) Bergey et al. (Bactersum eurydice White, U S. Dept. of Agr., Bur. of Entomol , Circ. 157, 1912, 3 and U. S. Dept. of Agr. Bull. 810, 1920, 15; Bergey et al . Manual. 2nd ed., 1925, 170.) From Greek Eurydice, the wife of Orpheus.

Rods: Small, slender, with slightly rounded ends, occurring singly and in pairs. Non-motile. Gram-negative

Gelatin stab: A bluish-gray growth occurs along the line of inoculation. No liquefaction.

Glucose agar colonies: Bluish-gray, circular, smooth, glistening, entire.

Broth: Uniform turbidity with viscid sediment.

Litmus milk: Unchanged.

Acid from glucose but little or no action on other carbohydrates.

Potato: Slight, grayish growth.

Aerobic, facultative.

Innocuous when fed to bees. Not pathogenic when inoculated subcutaneously in rabbits.

Source. Occurs as a secondary invader in European foulbrood of bees

Habitat: Unknown.

12. Achromobacter delmarvae Smart (Smart, Jour. Bact., 28, 1932, 41 and Jour. Agr. Research, 51, 1935, 363.) From Delmarva, coincd from Del., Mar and Va., the regions in which the species was found.

Short rods. Average size 0.75 by 1.5 microns, with rounded ends, occurring singly, in pairs and in short chains. Non-motile. Gram-negative

Gelatin colonies Similar to agai

Gelatin stab: Scanty growth. No

Beef-infusion agar colonies: Small, circular, raised, edges smooth, glistening, translucent, bluish-white, amorphous, margin entire

Agar stab Abundant growth Surface growth round, smooth, glistening, bluish-white, raised Fihform growth the whole length of stab, but growth best at top.

Agar slant Abundant filiform growth, raised, glistening, smooth, translucent, bluish-white, no odor; old cultures slightly viscid Medium unchanged.

Nutrient broth: Turbid. Delicate white pellicle. Sediment abundant, white, slightly stringy. No odor. Color of medium unchanged. Sterile milk: Slow growth. No peptonization. Coagulation in 12 to 14 days. Milk turns chocolate brown beginning at top.

Litmus milk: Acid with reduction of litmus in 5 days. Coagulation with return of pink color in 12 to 14 days. Browning of medium.

Potato: Abundant growth, grayishwhite, glustening, smooth, raised. Medium changed from white to smoke-gray. Indole not formed.

Nitrites produced from nitrates in 7 days at 26°C.

No H2S produced.

Ammonia not formed.

Diastatic action weak.

Acid but no gas from glucose, lactose, glycerol and mannitol. Alkaline reaction and no gas from sucrose.

Optimum pH 70.

Temperature relations: Optimum 26°C. Good growth up to 31°C. Very slight growth at 37° and at -8°C.

Facultative anaerobe.
Source: Isolated from fresh strawberries from Delaware, Maryland and Virginia.

Habitat: Unknown.

Appendix: Many of the following species were described before Gram and flagella stains had been perfected Hence it is impossible to identify them definitely as belonging to Achromobacter. Comparative study is needed in other cases before the remaining species can be placed in their proper place in the genus. (Chester) acidum Achromobacter Bergey et al. (Species No. 56 of Conn, Storrs Agr Exper. Sta , 7th Ann Rept. for 1891, 1895, 83; Bacterium acidum Chester, Man. Determ. Bact., 1901, 146, Bergey et al., Manual, 1st ed , 1923, 151.) From milk. See Manual, 4th ed., 1934, 246 for a description of this organism

Achromobacter agile (Ampola and Garino) Bergey et al. (Bacillus dentrificans agilis Ampola and Garino, Cent. f. Bakt., II Abt., 2, 1806, 673; Bacterium denitrificans agilis Chester, Ann. Rept Del Col Agr. Exp Sta., 9, 1807, 76, Bacterium agile II Jensen, Cent. f Bakt, II Abt., 4, 1808, 408; Bactellus adentificans Migula, Syst d Bakt., 2, 1900, 796, not Bacillus dentificans Chester, Man Determ Bact., 1901, 274, Bacillus agils Chester, Man Determ Bact., 1901, 226, not Bacillus agils Techsitowitsch, Berl klin Wehnschr, 1892, 512, Bergey et al., Manual, 1st ed., 1923, 138) From cow manure See Manual, 4th ed., 1034, 219 for a description of this organism

Achromobacter album (Lisenberg) Bergey et al. (Bacillus albus Lisenberg,
Bakt. Dung, 3 Auft., 1891, 171, Bacterium
albus Chester, Ann Rept. Del. Col
Agr. Exp Sta., 9, 1897, 76, Bergey et al,
Manusl, 1st ed., 1923, 141) From
water Gibbons (Contrb. to Canadian
Biol and Fish, 8, No. 22, 1934, 279)
reports this species from the slime on
cod (Gadus callarius). See Manusl,
4th ed., 1931, 222 for a description of this
organism

Achromobacter amylotorum (Rubentschick) Bergey et al (Urobacterium amylotorum Rubentschick, Cent f Bakt, II Abt, 64, 1925, 168, sbd, 68, 1926, 161; Bergey et al, Manual, 3rd ed, 1930, 225.) From sewage slime Sec Manual, 5th ed, 1939, 514 for a description of this organism.

Achromobacter anaerobium Shimwell. (Jour. Inst. Brewing, 43, 1937, 507) From spoiled beer.

Achromobacter aromafacterus (Chester)
Bergey et al. (Species No 41 of Conn,
Storrs Agr. Exper Sta, 7th Ann Rept
for 1801, 1805, 67, Bacterium connii
Migula, Syst d Bakt, 8, 1900, 440;
not Bacterium connii Chester, Man.
Determ Bact., 1901, 146; Bacterium
aromafactens Chester, toc. ct., 148;
l'ergey et al, Manual, 1st ed, 1923,
151) From milk sent from Uruguay to
Chicago World's Fair. See Manual,
5th ed, 1939, 519 for a description of this
organism.

Achromobacier arcticum Rusakows and Butkewitsch. (Microbiology (Russian), 10, 1941, 137; abst. in Cent f. Bakt, II Abt., 105, 1942, 140) From sea water (Barents Sea)

Achromobacter candicans (Frankland and Frankland) Bergey et al (Bacillus candicans G and P. Frankland, Itsehr f Hyg , 6, 1889, 397; Bacterium candicans Chester, Ann. Rept. Del. Col Agr. Evp. Sts. 9, 1897, 139; Bergey et al., Manual, 1sted , 1923, 149) From soil. See Manual, 5th ed, 1939, 520 for a description of this organism.

Achromobacter centropunctatum (Jensen) Bergey et al. (Bacterium centropunctatus II. Jensen, Cent. F Bakt., II. Abt., 4, 1898, 410; Bacillus centropunctatus Chester, Man. Determ. Bact., 1901, 225, Bergey et al., Manual, 1st ed., 1923, 139) From cow manure. See Manual, 4th ed., 1034, 220 for a description of this organism.

Achromobacter eccecideum (Chester) Bergey et al (Species No. 16 of Conn, Storra Agr Evper Sta., 6th Ann Rept. for 1833, 1891, 51; Bacterium coccideum Chester, Man. Determ Back., 1901, 147; Bergey et al., Manual, 1st ed., 1902, 152.) From ripening cream See Manual, 5th ed., 1939, 520 for a description of this organism.

Achromobacter connii (Chester) Bergey et al. (Culture No. 55, Conn, Storrs Agr Evp. Sta, 7th Annual Rept. for 1894, 1895, 83, Bactersum connis Chester, Man. Determ. Bact, 1901, 146, Bergey et al., Manual, 1st ed., 1923, 149.) From milk. Sec Manual, 4th ed. 1031, 213 for a description of this organism

Acknowbacter dendriteum (Lustus)
Bergey et al (Bacillus dendriteus
Lustus, Dagnostica dei batteri delle
acque, Torino, 1890 and Diagnostik der
Bikterien des Wassers, 1893, 99; Bacterium dendritieus Chester, Ann. Rept
Del. Col Agr. Fup. Sia., 9, 1897, 103;
Bergey et al, Manual, 2nd ed., 1925, 156 )
From water. See Manual, 5th ed,
1939, 991 for a description of this organism.

Achromobacter epsteinii Peshkov. (Peshkov, Jour. of Biology (Russian), 6, 1937, 1993.) From water of a carp pond near Moscow.

Achromobacter fermentationis (Chester) Bergey et al. (Bacterium fermentationis Chester, Del. Agr. Exp. Sta. Rept. 1899, 53; Bergey et al., Manual, 1st ed., 1923, 152.) From soil. See Manual, 4th ed., 1934, 247 for a description of this organism In Chester, Man. Determ. Bact., 1901, 231 this is listed as a synonym of Bacillus foetidus-liquefaciens Tavel, Ueber Actiol. der Strumitis, Basel, 1892.

Achromobacter filefaciens (Jensen)
Borgey et al. (Bacterium filefaciens
H. Jensen, Cent. f Bakt., II Abt., 4,
1898, 401; Bergey et al., Manual, 1st
ed., 1923, 153) From dust. See Manual, 4th ed., 1934, 247 for a description
of this organism.

Achromobacter formosum (Ravenel)
Bergey et al. (Bacillus formosus Ravenel, Memoirs Nat. Acad. Sci., 8, 1896,
12; not Bacillus formosus Bredemann and
Heigener, Cent. f. Bakt., II Abt., 83,
1935, 101; Bacterium formosus Chester,
Ann. Rept. Del. Col. Agr. Evp. Sta., 9,
1897, 91, Bergey et al., Manual, 1st ed,
1923, 136.) From soil. Gibbons (Contrib to Canadian Biol. and Fish, 8, No.
24, 1934, 303) reports this species from
fillets of haddock (Melanogrammus aeglefinus). See Manual, 5th ed., 1939, 505
for a description of this organism.

Achromobacter galophilum Bergey et al. (Culture No. 27, Baranik-Pikowsky, Cent f. Bakt., II Abt., 70, 1927, 373, Bergey et al., Manual, 3rd ed., 1930, 223) From sea wnter See Manual, 5th ed., 1939, 514 for a description of this orcanism.

Achromobacter gasoformans (Eisenberg) Bergey et al. (Gasbildner Bacilus, Tils, Zeitschr. f. Hyg., 9, 1890, 315; Bacilus gasoformans Eisenberg, Bakt. Diagnostik, 1891, 107; Bacterium gasoformans Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1897, 93; Bergey et

al., Manual, 1st ed., 1923, 137.) From water. See Manual, 5th ed., 1939, 503 for a description of this organism. Gas bubbles observed in plain gelatin stab.

Achromobacter geminum (Chester) Bergey et al. (Bacillus geminus minor Ravenel, Memoirs Nat Acad. Sci., 8, 1896, 28; Bacterium geminus minor Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1897, 72; Bacillus geminus Chester, Man. Determ. Bact., 1901, 216; Bergey et al., Manual, 1st ed., 1923, 142.) From soil. See Manual, 5th ed., 1939, 508 for a description of this organism.

Achromobacter gutlatum (Zimmer-mann) Bergey et al. (Bacillus gut-tatus Zimmermann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1, 1800, 56; Bacterium gutlatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1807, 94; Bergey et al., Manual, 1st ed., 1923, 140.) From water. See Manual, 5th ed., 1939, 503 for a description of this oreanism.

Achromobacter halophilum Bergey et al. (Culture No. 36, Barnnik-Pikowsky, Cent. f. Bakt., II Abt., 70, 1927, 373; Bergey et al., Manual, 3rd ed., 1930, 220) From sea water. See Manual, 5th ed., 1939, 513 for a description of this organism.

Actromobacter hardlebii (Jensen)
Bergey et al. (Bacterium hardlebii II.
Jensen, Cent. f Bakt., II Abt., 4,
1898, 449, Bacillus hardlebii Chester,
Man Determ Bact., 1901, 226, Berget
al, Manual, Ist ed, 1923, 129.) From
soil. See Manual, 4th ed., 1934, 219 for
a description of this organism.

Achromobacter hyalinum (Jordan) Bergey et al. (Bacillus hyalinus Jordan, Report, Mass State Bd. of Health, 1830, 835; Bacterium hyalinus Chester, Ann. Rept Del. Col. Agr. Evp. Sta., 9, 1837, 95; Bergey et al., Manual, 1st ed., 1923, 1838.) From sand in a septic tank. See Manual, 4th ed., 1934, 216 for a description of this organism. Also reported by Hatcher (Jour Elisha Mitchell Sci. Scc.,

55, 1939, 332) from the feces of a cockroach (Periplaneta americana) Litmus milk acid and coagulated. Gram-negative.

Achromobacter inunctum (Pohl) Bergey et al (Bacillus munctus Pohl, Cent. I Bakt, 11, 1892, 143; Bacterium inunctus Chester, Ann Rept Del. Col. Agr Exp. Sta, 9, 1897, 94; Bergey et al, Manual, lat ed., 1923, 141.) From water. See Manual, 4th ed, 1934, 221 for a description of this organism

Achromobacter locateum Bergey et al (Kramer, Die Baktenologie der Landwirtschaft, z, 1892, 24, Bergey et al., Manual, 1st ed, 1923, 152) From simy milk. See Manual, 5th ed., 1939, 519 for a description of this organism This appears to refer to Loeffier's slimy milk bacillus, more correctly known as Bacterium vitutosum Micella

Achromobacter larvae (Stutzer and Wsorow) Bergey et al (Enterobacillus larvae Stutzer and Wsorow, Cent f Bakt, II Abt, 71, 1927, 119, Bergey et al, Manual, 3rd ed, 1939, 227) From intestinal tract of normal and diseased caterpillars of winterwheat cutworm (Euroa espetium). See Manual, 5the 64, 1939, 541 for a description of this organism.

Achromobacter Isquidum (Frankland and Frankland) and Frankland) Bergy et al (Bacillus liquidus G and P. Frankland, Zischr I. Hyg. 6, 1859, 382, Bacterium hipudum Chester, Ann. Rept. Del Col Agr Evp Sta. 9, 1897, 187; Pseudomonas liquida Chester, Man Determ Bact, 1901, 311, Bergey et al, Manual, 1st ed, 1923, 145) From water See Manual, 5the d, 1939, 511 for a description of this organism Achromobacter litorate (Russell)

Bergey et al. (Bacillus litoralis Russell, Ztachr I Hyg., 11, 1891, 199; Bacterrum litoralis Chester, Ann. Rept. Del. Col. kgr. Exp. Sta., 9, 1897, 91, Pseudomonas litoralis Mugula, Syst. d. Bakt., 2, 1905, 570, Bergey et al., Manual, 1st ed., 1923, 138) See Manual, 5th ed., 1993, 503 for a description of this organism. From mud bottom, Gulf of Naples. Achromobacter literale var. 2, Bois and Roy. (Naturaliste Canadien, 71, 1945, 259.) From intestine of the codfish (Gadus callarias L.).

Achromobacter untidletournii (Chester) Berger et al (Species No 53 of Conn, Storrs Agr. Exper. Sta., 7th Ann. Rept. for 1834, 1835, 82; Bacterium middletownii Chester, Man. Determ Bact., 1901, 147, Bergey et al., Manual, 1st cd., 1923, 151) From milk See Manual, 4th ed., 1934, 245 for a description of this orcanism.

Achromobacter mucidus Alford and McCleskey (Proc Louisiana Acad Sci., 7, 1943, 25) From erab meat having musty odor.

Achromobacter nijibetsus Takeda. (Cent. f Bakt, II Abt., 94, 1936, 48.) From fish hatchery water. Not pathogenic to salmon eggs.

Achromobacter nitrocorum (Jensen)
Bergey et al. (Bacterium nitrocorum
H Jensen, Cent f. Bakt., II Abt., 4,
1898, 450, Bergey et al, Manual, 1st
ed, 1923, 154) From horse manure
See Manual, 4th ed, 1934, 218 for a
description of this organism.

Achromobacter perolens Turner. (Australian Jour. Exp. Biol. and Med. Sci., 4, 1927, 57) From musty eggs

Acknomobacter pestifer (Frankland and Frankland) Bergey et al. (Bacillus pestifer G. and P. Frankland, Philosoph Trans Roy. Soc., London, B., 178, 1838, 277, Bacterium pestifer Chester, Ann. Rept. Del. Col. Agr. Evp. Sta. p., 1807, 69, Bergey et al., Manual, 1st ed., 1923, 140) From dust. See Manual, 5th ed., 1939, 607 for a description of this organism

Achromobacter pilousskyn Bergey et al (Culture No. 25, Baranik-Pikonsky, Cent f Bakt, II Abt., 70, 1927, 373; Bergey et al, Manuel, 37d ed., 1930, 222) From sea water See Manual, 5th ed., 1939, 514 for a description of this organism

Achromobacter pinnatum (Ravenel) Bergey et al. (Bacillus pinnatus Ravenel, Memoirs Nat. Acad. Sci., 8, 1896, 32; Bacterium pinnatus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 72, Bergey et al., Manual, 1st ed., 1923, 142). From soil. S.e Manual, 4th ed., 1934, 223 for a description of this organism.

Achromobacter ravenelii Bergey et al. (Bacillus geminus major Ravenel, Menoirs Nat Acad. Sci., 8, 1896, 27; Bacillus ravenelt (Chester, Man. Determ. Bact., 1901, 217; Bergey et al., Manual, 1st ed., 1923, 143.) From soil. Gibbons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1034, 279) reports this species from the slime on cod (Gadus callarias). See Manual, 4th ed., 1934, 224 for a description of this oreanism.

Achromobacter refractans (Wright) Bergey et al (Bacillus refractans Wright, Mem Nat. Acad. Sci. 7, 1894, 442; Bacterium refractans Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 82; Bergey et al , Manual, 1st ed., 1923, 150.) From water. See Manual, 4th ed., 1934, 244 for a description of this organism

Achromobacter reticulare (Jordan)
Bergey et al. (Bacillus reticularis
Jordan, Rept. Mass. State Bd of Health,
1890, 834; Bergey et al., Manual, 1st
ed., 1923, 144) From the effluent of a
sepute tank. See Manual, 5th ed., 1939,
510 for a description of this organism.

Achromobacter rodonatum (Ravenel) Bergey et al. (Bacillus rodonatus Ravenel, Memoirs Nat. Acad Sci, 8, 1896, 40; Bacterium rodonatus Chester, Ann. Rept Del Col Agr Exp. Sta., 9, 1897, 83, Bergey et al., Manual, 1st ed., 1923, 150) From soil. See Manual, 4th ed., 1934, 244 for a description of this oreanism.

Achromobacter rugosum (Chester) Bergey et al (Species No 27, Conn, Storrs Agr Exp. Sta., 1893, 54, Bacullus rugosus Chester, Man. Determ. Bact., 1901, 229; not Bacterum rugosum Henrici, Arb Bakt. Inst. Tech. Hochschule Karlsruhe, 1, 1894, 43; not Bacillus rugosus Wright, Memoirs Nat Acad. Sci., 7, 1895, 438; Bacterium geminus major Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 73; Bergey et al., Manual, 1st ed., 1923, 143.) From soil. See Manual, 4th ed., 1934, 24f or a description of this organism.

Achromobacter sewerinii Bergoy et al. (Kultur No. 3, Sewerin, Cent. f. Bakt, II Abt., I, 1895, 162; Vibrio denitrificans Sewerin, Cent. I. Bakt., II Abt., 3, 1877, 517; Bergey et al., Manual, 1st ed., 1923, 140.) From borse manure.

Achromobacter solutarium (Ravenel)
Bergey et al. (Bacillus solutarius Ravenel, Memoirs Nat. Acad. Sci. 8, 1896, 29;
Bacterium solitarius Chester, Ann. Rept
Del. Col. Agr. Exp. Sta., 9, 1897, 71,
Bergey et al., Manual, 1st ed., 1923, 143.)
From soil. Gibbons (Contrib. to Candian Biol. and Fish., 8, No. 22, 1934, 279)
reports this species from the slime on cod
(Gadus callarias). See Manual, 5th ed.,
1939, 509 for a description of this orcanism.

Achromobacter stutzeri (Lehmann and Neumann) Bergey et al., (Bacillus denirificans II, Burri and Stutzer, Cent. f. Bakt., II Abt., 1, 1895, 392; Bacterum stutzeri Lehmann and Neumann, Bakt. Disg., 1 Aufl., 2, 1896, 237; Bacillus nutogenes Migula, Syst. d. Bakt., 2, 1900, 793; Bacillus stutzeri Chester, Man Determ. Bact., 1901, 225; Bergey et al., Manual, 3rd ed., 1930, 207.) From horse manure. See Manual, 4th ed., 1934, 221 for a deviction of the company of the compa

scription of this organism. Achromobacter tiogense (Wright) Ber-(Bacillus tiogensis Wright, gey et al Memoirs Nat. Acad. Sci., 7, 1894, 441; Bacterium tiogensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 82; Bergey et al., Manual, 1st ed., 1923, 150 ) From water. See Manual, 4th ed., 1934, 244 for a description of this organism ubiquitum (Jordan) Achromobacter Bergey et al. (Bacillus ubiquitus Jordan, Rept Mass. State Bd. of Health, 1890, 830, Bacterium ubiquitus Chester, Ann. Rept. Del Col. Agr. Exp Sta., 9, 1897, 144; Bergey et al , Manual, 1st ed., 1923,

153.) From sewage, water and dust See Manual, 5th ed., 1939, 517 for a description of this organism.

Achromobacter renenosum (Vaughan) Berrey et al (Bacillus renenosus Vaughan, Amer. Jour. Med Sci. 104. 1892, 191, Bergey et al , Manual, 1st ed , 141 ) From nator Gibbons (Contrib to Canadian Biol, and Fish . 8. No. 22, 1934, 279) reports this species from the slime on cod (Gadus callarias) and the feces of dogfish (Squalus acanthias). See Manual, 4th ed., 1934, 222 for a description of this organism

Achromobacter visco-symbioticum (Buchanan and Hammer) Berrey et al. (Bacillus risco-sumbioticum Buchanan and Hammer, Jone Agr. Exp. Sta Res. Bull 22, 1915, 261: Escherichia symbiotica Bergey et al., Manual, 1st ed., 1923. 202; Bergey et al . 3rd ed . 1930, 209) From rony milk. See Manual, 4th ed 1934, 223 for a description of this organism

## Genus III Flavobacterium Bergeu et al.\*

(Bergey et al., Manual, 1st ed., 1923, 97, Flavobacter Stewart, Jour. Mar. Biol. Assoc. Un Kingdom. 13, 1932. 41 ) From Latin flatus, vellow and bacterium, a small rod

Rods of medium size forming a vellow to orange pigment on culture media. Motile with peritrichous flagella or non-motile Generally Gram-negative. Characterized by feeble powers of attacking carbohydrates, occasionally forming acid from hexoses but no gas Occur in water and soil

The type species is Flavobacterium aquatile (Frankland and Frankland) Bergey et al

### Ken to the species of genus Flavobacterium.

- I. Non-motile, and slow or no liquefaction of gelatin
  - A Litmus milk unchanged
    - I Nitrites not produced from nitrates
- 1 Flarobacterium aquatile.
- II Motile with peritrichous flagella.
  - A Gelatin liquefied
    - I Litmus milk unchanged.
      - a Nitrites amduced from nitrates

        - 2 Flavobacterium diffusum 3 Flavobactersum okeanokortes.
        - 4 Flavobacterium rigense.
      - as Nitrites not produced from nitrates b. From fresh water.
- 5 Flasobacterium devorans.
- bb From sea water
- 6. Flavobactersum marsnotypicum.
- 7 Flatobacterium marinotirosum. 8. Flavobacterium halohydrum.
- 9 Flavobacterium neptunium.

<sup>·</sup> Partially rearranged before his death by Prof D. H. Bergey, Philadelphia. Pennsylvania, Sept., 1937; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, June, 1945.

- 2. Litmus milk alkaline.
- a. Nitrites produced from nitrates.
  - 10. Flavobacterium suaveolens.
  - 11. Flavobacterium rhenanus as. Nitrites not produced from nitrates.
    - 12. Flasobacterium marinum.
- 13 Flavobacterium harrisonis.
- B. Gelatin not liquefied.
  - 1. Litmus milk unchanged.
    - a. Nitrites not produced from nitrates.
  - 14. Flanobacterium inmerble
  - 2. Litmus milk acid
    - a. Nitrites not produced from nitrates.
      - 15 Flavohacterium lactis

## III. Non-motile.

- Gelatin liquefied.
  - 1. Litmus milk unchanged.
- 16. Flavobacterium sewanense
- 2. Litmus milk reduced
  - a Nitrites not produced from nitrates.
    - 17. Flavobacterium arborescens.
- 3' Litmus milk alkaline
  - a. Nitrites produced from nitrates.
    - 18. Florohacterium lutescens. 19. Flavohacterium fucatum.
- 4. Litmus milk pentonized.
  - Nitrites not produced from nitrates.
    - 20. Flavobacterium esteroaromaticum.
- 5. Litmus milk acid
  - a Nitrites produced from nitrates
    - 21. Flavobacterium balustinum.
    - 22 Flavobacterium dormitator.
- 6. Action on litmus milk not recorded. Rust-colored on blood agar. 23. Flavobacterium ferrugineum
- B. Gelatin not liquefied
  - Litmus milk unchanged.
    - Nitrites produced from nitrates.
      - 24 Flavobacterium proteus.
    - aa. Nitrites not produced from nitrates.
      - 25. Flanobacterium breve.
      - 26. Flavobacterium solare.
- C. Action on gelatin not recorded
  - 1. Litmus milk unchanged
    - a Nitrites produced from nitrates.
      - 27. Flavobacterium flavotenue.
- 1. Flavobacterium aquatile (Frankland and Frankland) Bergey et al. (Bacillus aquatilis G. and P. Frankland,
- Ztschr. f. Hyg., 6, 1889, 381; Bacterium aquatilis Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 96; Bergey et

al., Manual, 1st ed , 1923, 100.) From Latin aquatilis, aquatic

Description taken from Frankland and Frankland and from studies by Dr E Windle Taylor, Metropolitan Water Board, London, on freshly isolated cultures.

Rods 05 by 25 microns, with rounded ends, occurring singly, in pairs and in chains. Oscillatory movement only; long threads often remaining motionless (Franklands) Gram-negative (Taylor)

Gelatin colonies Center yellow-brown, with radiate arrangement of bundles of threads. Colorless margin Very slow liquefaction (none in 6 weeks, Taylor). Gelatin stab: Yellow surface growth.

Slow liquefaction.

Agar slant . Yellow, smooth, glistening limited growth

Broth Turbid with whitish sediment No pellicle

Litmus milk. Unchanged (Taylor)
Potato. Limited, yellow streak to no

growth
Indole not formed (Taylor).

Nitries not produced from mitrates

Aerobic, facultative. Optimum temperature 25°C.

Distinctive characters Resembles Flavobacterium arborescens microscopically, easily distinguished from this organism by its much slower and limited growth on ordinary gelatin and agar media, the marked difference in the appearance of colonies and the inability of Flavobacterium agualité to produce

Source: Isolated from the water of deep wells in the chalk region of Kent, England where it occurred as a practically pure culture. Found abundantly and reisolated by Taylor, 1941 from the same sources (personal communication)

more than a limited growth on potato

Habitat Water

Nore The pertrichous, nutrate reducing and ammonia producing organism identified by Bergey (loc. et!) in 1923, as Flarobacterium aquatile appears to have been something resembling Flarobacterium diffusum. 2. Flavobacterium diffusum (Frankland) Bergey et al. (Bacillus diffusus G. and P. Frankland, Ztschr. f. Hyg., 6, 1889, 296; Bacterium diffusus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 97; Bergey et al., Manual, 1st ed., 1923, 100.) From Latin diffusus, spreading out. diffuse.

Description completed from Harrison (Canadian Jour. Res., 1, 1929, 233) as indicated.

Rods: 0.5 by 1.5 microns, occurring singly and in chains. Motile, possessing peritrichous flagella Gram-negative (Harrison).

Gelatin colonies: Thin, bluish-green, spreading, later faint vellow.

Gelatin stab: Thin, glistening, yellowish-green surface growth Slow crateri-

form liquefaction.

Agar slant Thin, light yellow, glisten-

ing Broth. Turbid, with greenish-yellow sediment.

Litmus milk Unchanged (Harrison).
Potato: Thin, smooth, greenish-yellow,
glatening growth.

Indole not formed (Harrison). Nitrites produced from nitrates (Har-

Nitrites produced from nitrates (Harrison).

Slight acidity from glucose. No acid from sucrose and lactose (Harrison). Aerobic, facultative

Optimum temperature 25° to 30°C. Source: Originally found in soil. Found also by Tataroff (Die Dorpater Waserbakterien, Dorpat, 1891, 58) in fresh water and by Harrison (loc cit.) from sinn of halibut from both the Atlantie and Pacific shores of Canada.

Habitat Soil, fresh and sea waters.

 Flavobacterium okeanokoites Zo-Bell and Upham. (Buli. Scripps Inst. of Oceanography, Univ. Calif. 5, 1944, 270.)
 From Greek Oceanus, the ocean god, the ocean and coiles, bed.

Rods: 08 to 0.9 by 1.2 to 16 microns, with rounded ends, many coccoid, occurring singly and in long chains. Motile by means of peritrichous flagella. Gram-negative.

All media except the fresh-water broth. litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, convex, entire, rust or orange colored, digest gelatin.

Gelatin stab: Slow napiform liquefaction, yellow growth.

Agar colonies: 2 mm, circular, entire. smooth, convex.

Agar slant: Moderate, filiform, glistening, butvrous growth with vellow pigment.

Sea-water broth: No pellicle, moderate turbidity, moderate viscid sediment.

Fresh-water broth: Good growth. Litmus milk: No visible change.

Casein is digested.

Potato: No visible growth.

Indole not formed.

Nitrites slowly produced from nitrates. Does not produce acid or gas from glucose, lactose, maltose, sucrose, glycerol, mannitol, xylose, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide is formed Ammonia produced from peptone but not from urea.

Fats not hydrolyzed.

Aerobic, facultative

Optimum temperature 20° to 25°C. Source: Marine mud.

Habitat Sea water.

4 Flavobacterium rigense Bergey et al. (Bacillus brunneus rigensis Bazarewski, Cent f. Bakt, II Abt, 15, 1905, 1; Bergey et al , Manual, 1st ed., 1923. 100.) From Riga, the name of the city where the species was isolated

Rods: 0 75 by 1.7 to 2.5 microns, occurring singly. Motile, possessing peritrichous flagells. Gram-negative.

Gelatin colonies. Circular, entire to undulate, grayish-white, homogeneous. Gelatin stab: Smooth, yellowish surface growth. Infundibuliform liquefaction Brownish-yellow sediment.

Agar slant: Narrow, whitish streak, becoming yellowish-brown, spreading, Pigment is water and alcohol soluble. Insoluble in ether.

Broth: Turbid with pellicle and brownish sediment. Cells capsulated.

Litmus milk: Unchanged

Potato: Yellow, spreading growth The growth turns brownish.

Hydrogen sulfide not formed.

Indole not formed.

Nitrites produced from nitrates.

Aerobic, facultative,

Optimum temperature 30°C. Brownish colors develop best at lower temperatures. Orange-vellow colors develop best at 37°C.

Habitat . Soil.

5. Flavobacterium devorans (Zimmermann) Bergey et al. (Bacillus devorans Zimmermann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1, 1890, 48; Bacterium devorans Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 96; Bergey et al., Manual, 1st ed., 1923, 102.) From Latin devorans, devouring.

Characters added to Zimmermann's description by Bergey (loc. cit.) from his private notes are indicated. Steinhaus (Jour. Bact., 42, 1941, 771) apparently found the same organism.

Rods: 0.7 by 0.9 to 1.2 microns, occurring singly, in pairs and chains. Motile (Zimmermann), possessing peritrichous flagella (Bergey). Gram-negative (Zim-

mermann). Gelatin colonies: Circular, white, gran-

ular to filamentous, becoming yellowish-Gelatin stab: Slow infundibuliform

liquefaction Agar slant: Thin, gray, spreading

Broth · Turbid.

Litmus milk: Unchanged.

Potato: No growth (Zimmermann). Yellowish-gray streak (Bergey).

Indole not formed

Nitrites not produced from nitrates (Bergev).

Aerobic, facultative,

Ontimum temperature 25° to 30°C.

Source From water at Chemnitz (Zimmermann). From water (Bergey). From alimentary tract of the nine-spotted lady beetle (Coccinella novemnotata Habst.) (Steinhaus)

Habitat: Water.

 Flavobacterium marinotypicum Zo-Bell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Cahr., 5, 1944, 268.)
 From Latin marinus, of the sea and typicus. typical.

Rods: 0 5 to 0 7 by 1.4 to 2 0 microns, occurring almost entirely as single cells. Motile by means of four or more peritrichous flagells. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with see a stor

with sea water.
Gelatin colonies: Very minute, yellow,

with slow liquefaction.

Gelatin stab: Crateriform liquefaction becoming stratiform. Filiform along line of stab.

Agar colonies. Minute, circular, entire, convex, yellow.

Agar slant: Scanty, filiform, butyrous, shiny growth with yellow pigment

Sea-water broth: Scanty, yellowish pellicle, heavy turbidity, slight viscid sediment.

Fresh-water broth Good growth Litmus milk: Decolorized, neutral, greenish pellicle, slow peptonization. Potato: Abundant, shiny, greenish-yel-

low growth. Potato darkened.

Indole not formed

Nitrites not produced from nitrates Produces acid but no gas from glucose

and glycerol. Does not ferment lactose, sucrose, mannitol, xylose, or salicin.

Starch not hydrolyzed.

Hydrogen sulfide is formed.

Ammonia produced from peptone but not from urea.

Fats not hydrolyzed. Aerobic, facultative. Optimum temperature 20° to 25°C. Source: Sea water and marine mud. Habitat: Sea water.

 Flavobacterium marinovirosum Zo-Bell and Upham. (Bull. Scripps. Inst of Oceanography, Univ. Calif., 6, 1944, 271) From Latin marinus, of the sea, and virosus, covered with slimy liquid or 0020.

Rods. 07 to 08 by 08 to 28 microns, with rounded ends, occurring singly and in long chains Motile by means of peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with see water.

with sea water Gelatin colonies: Small, circular, raised, rust-colored. Slowly digest gel-

raised, rust-colored. Slowly digest genatin.

Gelatin stab: Crateriform liquefaction

becoming stratiform Light orange pigment.

Agar colonies 1 to 2 mm, circular, con-

vex, entire, smooth
Agar slant: Moderate, filiform, glisten-

Agar slant: Moderate, filiform, glistening, mucoid growth with grayish-yellow pigment.

Sea-water broth. Heavy turbidity, no pellicle, abundant viscid sediment. Fresh-water broth: Good growth.

Litmus milk: No visible change. Casein is digested.

Potato No visible growth.

Indole not formed.

Nitrates not produced from nitrates.

Does not ferment glycerol, glucose, lactose, maltose, sucrose, mannitol, xylose, or salicin.

Starch not hydrolyzed

Hydrogen sulfide is formed.

Ammonia produced from peptone but not from urea. Tats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C,

Source: Sea water and marine mud. Habitat: Sea water.

 Flavobacterium halohydrium ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calil., 5, 1944, 278.) From Greek hals, salt and hydror, water.

Short rods: 0.6 by 0.8 to 1.0 microns, occurring singly. Motile by means of many peritrichous flagells. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, eircular, orange.

Gelatin stab: Napiform liquefaction becoming erateriform. Beaded along line of stab.

Agar colonies: 2 mm, pulvinate, circular, entire, smooth.

Ager slant: Moderate, glistening, echinulate, butyrous growth with yellow pig-

Sca-water broth: Yellow surface ring, heavy turbidity, moderate viscid sediment.

Fresh-water broth: No visible growth.

Litmus milk: No visible change.

Casein not digested.

Very poorly tolerant of increases or decreases in salinity.

Potato. No visible growth.

Indole not formed.

Indole not formed.

Nitrites not produced from mirates.

Produces acid but no gas from glucose, lactose, maltose, sucrose, and salicin.

factose, maltose, sucrose, and salicia.

Does not ferment glycerol, mannitol, or sylose.

Stand is hydrolyced

Starch is hydrolyzed

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Fats not hydrolyzed.

Aerobic, facultative

Optimum temperature 20° to 25°C Source. Sea water and marine mud.

Habitat: Sea water.

 Flavobacterium neptunium ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calit., δ, 1944, 278.)
 From Latin Neptunius, god of the sea.

Rods: 0 5 to 0.6 by 1.6 to 4.5 microns, many bent rods, occurring singly and in short chains. Motile by means of long, peritrichous flagella. Gram-negative.

All media except the fresh-water broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, darker centers, sink in gelatin, faintly yellow.

Gelatin stab: Slow napitorm liquetaction. Filiform growth along line of stab. Agar colonies: 2 mm, circular, smooth, entire, convex, dark centers with buff

pigment.
Agar slant: Luxuriant, echinulate, glistening, slightly mucoid growth with buil to yellow pigment. Agar discolored howen.

Sea-water broth: Heavy pellicle, scanty turbidity, scanty sediment.

Fresh-water broth: No visible growth. Litmus milk: No visible change. Casein not directed.

Potato: No visible crowth.

Indole not formed.

Nitrites not produced from nitrates Produces acid but no gas from glucose, lactose, maltose, and salicin. Does not ferment glycerol, mannitol, xylose, or suchness.

Starch is hydrolyzed. Hydrogen sulfide not formed.

Ammonia produced from peptone but

not from urea. Fats not hydrolyzed.

Aerobie, facultative. Optimum temperature 20° to 25°C.

Source: Marine bottom deposits.

Habitat: Sea water.

 Flavobacterium suaveolens Soppeland. (Jour. Agr. Res., 28, 1924, 275)
 From Latin suaveolens, of a sweet odor.

Hods · 0.6 to 0.8 by 1.0 to 1.2 microns, with rounded ends, occurring eingly and in pairs. Mottle, with peritrichous fagella. Gram-negative on plain agar. Gram-positive in young culture on mitk powder span.

Gelatin stab. Rapid stratiform liquefaction. Medium becomes brown.

Agar colonies: Small circular smooth vellow, amorphous, undulate margin

Agar slant: Moderate, flat, glistening, opaque, butyrous, vellow, with aromatic ~d~=

Broth . Turbid with scanty sediment Aromatic odor, becoming cheesy

Litmus milk: Pentonized Alkaline. Potato · Abundant vellow elistening becoming brown.

Indola formed

Nitrites are produced from nitrates.

Hydrogen sulfide formed

Slight acid but no gas from glucose. sucrose and glycerol. No acid from lac-

tose

Starch hydrolyzed. Blood serum is hovefied

Aerobic, facultative. Ontinum temperature 25°C.

Source Dairy wastes

Habitat : Haknowa

11 Flavobacterium thenanus (Migula) Berrey et al. (Rhine water bacıllus of Burri, Frankland and Frankland, Microorganisms in Water, 1894, 483, Bacillus rhenanus Migula, Syst. d Bakt., 2, 1900. 713. Bacillus then: Chester, Manual Determ Bact . 1901. 251: Bergev et al . Manual, 1st ed , 1923, 103 ) Named for the Rhine River.

Characters added to Burn's description by Bergey (loc cit ) from his private notes are indicated Steinhaus (Jour Bact , 42, 1911, 771) apparently found the same organism and has added other characters

Rods 07 by 25 to 3.5 microns, with rounded ends, occurring singly and in chains (Burri). Motile, possessing peritrichous flagella (Bergey) Gram-negative (Bergey)

Gelatin colonies Convey, colorless, transparent, becoming vellowish Gelatin stab Infundibuliform lique-

faction Agar colonies Small, smooth, convex,

entire. Glycerol agar slant Thin, shining, honey-colored Growth dry and tough

Broth: Turbid, with orange-colored nellicle and sediment

Litmus milk: Soft congulum, becoming slightly alkaline with yellow ring

Potato Moist, glistening, thin, flat. arenge to rust-colored

Indole not formed (Berrey).

Nitrates produced from nitrates (Ber-

Acid from plucose, maltore and sucrose but not lactose (Steinhaus).

No hydrolysis of starch (Steinhaus). No H-S produced (Steinhaus).

Aerobic facultative

Optimum temperature 30°C.

Source. From Rhine River water (Burri). From water (Bergey) eggs in ovary of a walking stick (Dianheromera femorata Say) (Steinhaus).

Habitat, Presumably widely distributed in nature.

12 Flavohacterium marinum Harrison. (Canadian Jour. of Research, 1. 1929. 234) From Latin marinus, pertaining to the sea

Rods, 0.8 by 1.2 to 1.3 microns, with rounded ends Occur singly and in pairs. Motile with 4 to 5 peritrichous flacella. Encapsulated, Gram-variable. Show blue granules in Gram-negative

Gelatin colonies Circular, midescent, whitish margin with pale vellow center. Liquefaction.

Gelatin stab Saccate to stratiform Liquefaction

Agar colonies Circular, pale yellow, smooth, convey, granular, reticulate edge. Amber-yellow, slightly Agar slant raised, spreading, smooth, glistening,

transparent Ammonium phosphate agar Scant

growth

Broth Turbid, sediment

Litmus milk: Alkaline. without coagulation. Clear serum

Potato: Abundant, amber-vellow, becoming dirty vellow, spreading, glistening

Indole not formed,

Nitrites not produced from nitrates. Trace of ammonia formed.

Faint acidity from glucose. No action on lactose or sucrose.

Loeffler's blood serum not liquefied. Faint yellow spreading growth.

No H2S formed.

Aerobic, facultative.

Optimum temperature 20° to 25°C.

Source: Isolated from living halibut obtained at 30 to 50 fathons, Pacific Ocean. Globons (Contrib. to Canadian Biol. and Fish., 8, No. 22, 1934, 279) reports this species as occurring in the slime and feces of cod (Gadus callarias), halibut (Hippoglossus hippoglossus) and skate (Raja crinacea).

Habitat. Skin and feces of fishes.

13 Flavobacterium harrisonii Bergey et al. (Variety No. 6, Harrison, Rev. gén. du Lait, 6, 1905, 129; Bacillus lactis harrisonii Conn, Esten and Stocking, Ann. Rept. Storts Agr. Exp. Sta., 1909, 169; Bergey et al., Manual, 1st ed., 1923, 104.) Named for Prof. F. C. Harrison, the Canadian bacteriologist who first isolated this species.

Rods 0 25 to 0.75 by 0.3 to 3 5 microns, occurring singly and occasionally in short chains. Motile, possessing peritrichous flagella. Gram-negative.

flagella. Gram-negative. Gelatin colonies. Small, gray, glisten-

ing, lobular, citron-yellow, slimy.

Gelatin stab Villous growth in stab.

Slow crateriform to napiform liquefac-

tion.

Agar slant: Luxuriant, viscous, spreading, becoming dirty, to brownish citronvellow.

Broth: Turbid, with viscid ring and gelatinous sediment, sweetish odor, alkaline.

Litmus milk: Colorless to gray and slimy, becoming yellow, alkaline.

Potato. Luxuriant, yellow, spreading, slimy.

Indole not formed.

Glucese, lactose, maltose and sucrose broth turn alkaline with a disagreeable odor. Reaction of glycerol broth remains neutral.

Aerobic, facultative.

Optimum temperature 25°C. Source: Slimy milk.

Habitat: Unknown.

14. Flavobacterium invisibile (Yaughan)
Bergey et al. (Bacillus invisibilis
Yaughan, American Jour. Med. Sci., 104,
1892, 191; Bacterium invisibilis Chester,
Ann. Rept. Del. Col. Agr. Exp. Sta, 9,
1897, 77; Bergey et al., Manual, 1st ed.,
1923, 190.) From Latin invisibilis, not
visibile.

Rods: 0 6 to 0.7 by 1.2 to 2 0 microns, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies: Pale yellow, burrlike, with irregular margin.

Gelatin stab: Scanty growth on surface. Good growth in stab. No liquefaction. Agar colonies: White, convex, smooth,

serrate.

Agar slant: Limited, thick, white streak.

reas. Broth: Turbid.

Litmus milk: Unchanged.

Potato: No growth.

Indole not formed.
Nitrites not produced from pitrates.

Aerobic, facultative.

Optimum temperature 35°C.

Habitat · Water.

15. Flavobacterium lactis Bergey et al. (Bacillus aromaticus lactis Grimm, Cent. f. Bakt, II Abt., 8, 1902, 584; Bacillus aromaticus Grimm, ibid., 589; not Bacillus aromaticus Pammel, Bull. 21, Iowa Agr. Eyp. Sta., 1833, 792; Bergey et al., Manual, 1st ed., 1923, 103) From Latin lac, milk.

Rods 0.7 to 10 by 3.5 to 40 microns, occurring singly, in pairs and in chains. Motile, possessing peritrichous flagella.

Gram-negative.

sli iulate.

No liquefaction.

Agar slant: Slimy, vellowish, smooth, moint

Broth: Turbid, with abundant sadimant

Litmus milk : Slightly acid. Potato . Thick, slimy, brownish, with

vellowish margin. Indole not formed.

Natritag not produced from nitrotag Cultures have pleasant adar

Aerobic facultative

Ontinum temperature 25°C Source : Irolated from milk Habitat . Unknown

16. Flavobacterium sewanense (Kalantarian and Petrossian) Berrey et al Bacterium semanence Kalantarian and Petrossian Cent f Bakt II Abt . 85. 1932. 431 : Bergey et al , Manual, 4th ed , 1934, 160 ) From M. L. Sevan, a lake in Armenia.

Straight or curved rods: 10 to 2.0 by 40 to 50 microns on Molisch's agar, on meat extract agar and potato agar they are short or even coreoid Ends rounded, occurring singly or in pairs. Non-motile Gram reaction not given. Presumably negative.

Gelatin stab : Slow frauefaction.

Agar colonies Circular, raised, glistenone, dirty white. Deep colonies vellow and lens-shaped

Agar slant: Abundant, dirty yellow, plistening, raised.

Turbid with characteristic growth forms. Pellicle formed in old culfures.

Milk: Unchanged

CaCl

Potato: Yellow, raised, glistening, with darkening of the medium.

No visible cas produced from carbohydrates.

Crystals of calcium carbonate form in old cultures on CaCl; and Molisch's agar. Aerobic, facultative.

Ontimum temperature 20°C.

Source, Isolated from pellicle formed on surface of fish infusions in Lake Sevan and tap waters containing I per cent

Habitat . Sen water Thought to produce deposits of CaCOs in Lake Sevan S S P Ammania

17 Florehacterium arhorescene (Frankland and Frankland) Berrey et al. (Bacillus orberescens Frankland and Frankland, Ztschr. f. Hvc . 6, 1889, 379 also see Tils, Ztschr. f. Hyg., 9, 1890, 312; Zimmermann Bolt, unserer Trink, it Nutzwässer. 2, 1894, 20; and Wright, Mem. Nat. Acad Sci., 7, 1894, 446, var. a and b: Bacterium arborescens Chester. Ann. Rent Del Col. Agr. Exp. Sta. 9 1897, 106; Migula, Syst. d Bakt. e. 1900. 468 uses Racillus arhorescens in the toyt by mistake as Bacterium is used for other species in the genus and Bacterium arborescens is used in the index, p. 1058: not Bacillus arborescens Chester Man Determ. Bact , 1901, 249, Erythrobacillus arborescens Holland, Jour. Bact., 5, 1920. 217: Bergey et al , Manual, 1st ed., 1923. 113 ) From Latin arborescens, becoming a tree or tree-like.

Rods: 05 by 25 microns, occurring singly and in chains. Non-mottle (Franklands). Gram-negative (Zimmermann). Gelatin colonies: Radiate branching

filamenta. Center vellowish, bottler translucent. Gelatin stab: Liquefied with vellow

deposit.

Agar slant: Dirty orange growth. Broth . Turbid, with orange sediment

No pellicle. Litmus milk. Slow coagulation, litmus

reduced. Reaction unchanged (Wright). Potato Deep orange, luxuriant growth Nitrites not produced from nitrates.

Aerobic, facultative,

Optimum temperature 30°C. May belong to Corynebacterium (Leh-

mann and Neumann, Bakt. Ding., 7 Aufl. 2, 1927, 709).

Source: From river and lake water. Habitat: Water

17a Bacillus arborescens Chester. (Bacillus arborescens non-liquefaciens Ravenel, Mem. Nat. Acad. Sci., 8, 1896,

39; Bacterium arborescens non-liquefaciens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 103; not Bacterium arborescens non-liquefaciens von Rigler, Hyg. Rund., 12, 1902, 479; Chester, Man. Determ. Bact., 1901, 249.) Regarded by author as a non-liquefying strain of Bacillus arborescens Trankland and Frankland Not a yellow chromogen. From soil.

18. Flavobacterium lutescens (Aligula) Bergey et al. (Der gelbe Bacillus, Lustus, Duagnostik der Bakterien des Wassers, 1893, 78; Bacterium lutescens Migula, Syst d. Bakt., 2, 1900, 476; Bergey et al , Manual, 1st ed., 1923, 114.) From Latin lutum, yellow; lutescens, becoming yellowish

Rods 05 by 095 micron, occurring singly and in pairs. Non-motile. Gramnegative

Gelatin colonies. Circular, yellow,

Gelatin stab Slow liquefaction.

Agar slant Pale yellow, becoming golden vellow

Broth: Turbid

Litmus milk Alkaline

Potato Luxuriant, golden-yellow growth.

Indole not formed

Nitrites produced from nitrates

Aerobic, facultative Optimum temperature 30° to 35°C

Source From water Gibbons (Contrib. to Canadian Biol. and Fish, 8, No. 22, 1934, 279) reports this species as occurring in the slime of the cod (Gadus callarius)

Habitat Fresh and salt water

19 Flavobacterium fucatum Harrison. (Canadian Jour. of Research, 1, 1929, 232) From Latin fucatus, painted, colored.

Rods: 08 to 10 by 2.5 to 3.5 microns, slightly bent, with rounded ends. Granular with diphtheroid forms at 37°C. Nonmotile. Gram-negative.

Gelatin colonies: Circular, yellow, entire, paler at edges

Gelatin stab: Crateriform liquefaction Agar colonies: Circular, buff-yellon, smooth, shiny, convex to pulvinate, granular, entire.

Agar slant: Moderate, light buff-yellow, spreading, shiny, smooth.

Ammonium phosphate agar: Good growth in 6 days.

Broth: Turbid, becoming clear, pellicle and yellow sediment.

Litmus milk: Alkaline. Peptonized Clear serum. Yellow sediment.

Potato: Abundant, pale buff-yellow, smooth, spreading, becoming orange-yellow.

Indole not formed.

Nitrites produced from nitrates.

Traces of ammonia formed.

No acid from glucose, lactose or suc-

Loeffler's blood serum not liquefied Light buff-yellow growth becoming ochra-

ceus salmon. No H<sub>2</sub>S formed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Repeatedly isolated from living

Source: Repeatedly isolated from living halibut obtained at 30 to 50 fathoma, Pacific Ocean. Also isolated by Gibbons (Contrib. to Canadian Biol. and Fish. & No. 22, 1934, 279) from cod (Gadat callarus) and dogfish (Squalus acanthas).

Habitat : Skin of fishes.

20. Flavobacterium esteroaromaticum (Omelianski) Bergey et al. (Beterium esteroaromaticum Omelianski, Jour. Beet., 8, 1923, 407; Bergey et al., Manusl, 3rd ed., 1930, 149.) From M. L., ester and Greek aromaticus, aromatic.

Rods 05 by 1.0 to 30 microns Nonmotile. Gram reaction not recorded.

Gelatin stab: Crateriform liquelaction with odor of musk melons.

Agar colonies: Circular, yellow-brown, with fimbriate margin and a fruity aroms

Faint

Broth . Turbid, slight sediment fruity aroma.

Litmus milk: Pentonized Change odor

Potato: Abundant growth Disagree-

able oder Loeffler's blood serum: Liquefied

Indole not formed

Natrites not produced from nitrates Ammonia formed

Hydroren sulfide formed

Fat hydrolyzed.

Methylene blue reduced

No acid from carbohydrates. Aerobic, facultative

Ontimum temperature 30°C

Source Accidental contaminant in rabbut broup containing rabies virus

Habitat, Presumably widely distributod

21 Flavobacterium habitinum Harri-(Canadian Jour Research, 1, 1929, son

Rods 06 by 20 to 4.0 microns, forming short chains. Non motile Gram-nega-

Gelatin colonies, Circular, bright yel-

low center, entire

Gelatin stab · Liquefied Agar colonies Punctiform, cadmium-

vellow, convex, shiny, transparent Agar slant. Egg volk-vellow, semitransparent streak, smooth, shiny, be-

coming brownish-yellow. Ammonium phosphate agar Slight yel-

low growth. Broth . Turbid, with yellow sediment Litmus milk: Shehtly acid with vellow

sediment. Potato Scant, yellow growth

Indole not formed

Nitrites (trace) produced from nitrates Ammonia not formed

No action Faint acidity from glucose on lactose or sucrose.

Loeffler's blood serum not liquefied Fee yolk-like growth

No H2S formed. Aerobic, facultative.

Optimum temperature 20° to 25°C Source: Isolated from living balibut obtained at 20 to 50 fethome Peerfie

Occan

Habitet Slip of fisher

Flavohactorium domitates (Wright) Bergey et al. (Bacillus dormitator Wright, Memoirs Nat. Acad Sci. 7. 1895 442 Racterium dormitator Charter Ann Rent Del Acr Exp Sts 9 1807 109: Berrey et al., Manual, 1st ed., 1923. 115 ) From Latin dormitator, one who sleens

Description completed from Harrison (Canadian Jour. Res. 1, 1929, 233) whose cultures differed in some particulars from Wright's

Rods with conical ends, occurring singly, in pairs and in chains Non-motile. Gram-negative (Harrison).

Gelatin colonies, Small, vellow, slightly granular, liquefying

Gelatin stab. Infundibuliform house. faction, vellow sediment.

Agar slant . Yellow, glistening, translu-

Ammonium phosphate agar · Slight vellos growth

Broth Turbid, with slight pellicle and vellow sediment.

Litmus milk Slightly acid; litmus reduced. Harrison reports no reduction Poteto Slight, transparent, vellow

growth Indole not formed (Harrison).

Nitrite (trace) produced from nitrates (Harrison).

Acid from glucose, sucrose, glycerol and mannitol. No send from lactose, raffinose. and inula (Harrison)

Aerobic, facultative Ontimum temperature 30°C

Source, Originally isolated from fresh water at Philadelphia Later isolated by Harrison (loc. cit.) from skin of habbut taken in Pacific occan off Canada bons (Contrib. to Canadian Biol and Fish , 8, No. 22, 1934, 279) reports this Hence it is impossible to identify them definitely as belonging in Planobacterium. Comparative study is needed in some cases before other species listed here can be placed in their proper place in the genus.

Flavobacterium acidificum Steinhaus. (Jour. Bact., 42, 1911, 772.) From the intestine of the grasshopper (Conocephalus fasciatus De G.), the Colorado potato beetle (Lephnotares decemineata Say), several unidentified lady beetle larvae, and the white cabbage butterfly (Pierrs rapace L).

Flavobacterum antennforme (Ravenel)
Bergey et al (Bacillus antennformis
Ravenel, Memoirs Nat Acad. Sci., 8, 1896, 25; Bacterum antennformis
Chester, Ann Rept. Del. Col. Agr.
Lyp Sta., 9, 1897, 91, Bergey et al.,
Manual, 1st ed., 1923, 101) From
soil. See Manual, 5th ed., 1939, 531 for a
description of this organism

Flavobacterium airantiaeum (Frankland and Frankland) Bergey et al (Bacillus airantiaeus) G. and P. Frankland, Zeitschr. I. Hyg., 6, 1889, 390, Bacterium aurantiaeus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 100, Bergey et al., Manual, 1st. ed., 1923, 107, Chromobacterium aurantiaeum Topuley and Wilson, Prine Bact and Immun. 1, 1931, 405) From water. See Manual, 5th. ed., 1939, 533 for a description of this organism.

Flavobacterum aurantnum (Hammer) Bergey et al (Bacullus aurantinus Hammer, Research Bull. No 20, Iowa Exp Sta., 1915, 149, Bergey et al., Manual, 1st ed., 1923, 107.) From milk See Manual, 5th ed., 1939, 541 for a description of this organism

Flavobacterium aurescens (Ravenel) Bergey et al (Bacillus aurescens Ravenel, Memoirs Nat Acad. Sci., 8, 1856, 8; not Bacillus aurescens Frankland and Frankland, Philo Trans Roy. Soc. London, B, 1878, 271, Bacterium aurescens Chester, Ann Rept Del. Col. Agr Exp Sta., 9, 1897, 105; Bergey et al., Manual, 1st ed., 1023, 102) From soil, Gibbons (Contrib. Canadian Biol. and I'ish., 8, No. 21, 1931, 307) found this species in fillets of haddock (Melanogrammus aeglefinus). See Manual, 4th ed., 1934, 142 for a description of this organism.

Flavobacterium brunneum (Copeland) Bergey et al. (Baeillus brunneus Copeland, Rept. Filtration Commission, Pittsburgh, 1899, 348; Bergey et al., Manual, lat ed., 1923, 112.) From water. See Manual, 5th ed., 1939, 541 for a description of this organism. This may be Baeillus brunneus Schroeter, but not Baeillus brunneus Eisenberg. The latter forms spores.

Tlavobacterium . buccalis (Chester) Bergey et al. (Bacillus g, Vignal, Arch phys. norm. et path., Sér. 3, 8, 1886, 365; Bacillus buccalis minutus Sternberg, Manual of Bact., 1893, 643; Bacterium buccalis minutus Chester, Ann Rept. Del. Col. Agr. Evpt. Sta., 9, 1897, 108; Bacterium vignali Migula, Syst. d Bakt., 2, 1900, 443; Bacterium bucollis (sie) Chester, Man. Determ. Bact., 1901, 167; not Bacterium buccale Migula, Syst. d Bakt., 2, 1900, 445; Bacillus ugnalis Nepveux, Thèse Fac. Pharm., Paris and Nancy, 1920, 112; Bergey et al, Manual, 1st ed., 1923, 113.) From salıya. See Manual, 5th ed., 1939, 541 for a description of this organism

Flavobacterium butyri Bergey et al. (Bacillus aromaticus butyri Severn, Cent f Bakt., II Abt., II, 1903, 261; Dergey et al., Manual, 1st ed., 1923, 166) From sour cream. Produces an agreeable odor. See Manual, 5th ed., 1929, 534 for a description of this organism.

Flatobacterium chlorum Steinhaus. (Jour Bact., 42, 1941, 772) From the intestine of the nine-spotted lady beetle (Coccinclla novemnotata Habst.).

Flavobacterium denitrificans (Lehmana and Neumann) Bergey et al. (Bacillus denitrificans I, Burri and Stutzer, Cent f Bakt, II Abt, I, 1895, 300; Bacterium denitrificans I, Chestor, Ann Rept. Del. Col Agr Exp Sta, 9, 1897, 77, Bacterium denitrificans Lehmann and Neumann, Bakt. Diag, 2 Aufl, 2, 1809, 273; Pseudomons stutzeri Migula, Syst d Bakt, 2, 1900, 929, Bacillus dentirificans Chester, Man. Determ. Bact, 1901, 224, Bergey et al., Manual, 1st ed, 1923, 190, Chromobacterium dentirificans Topley and Wilson, Princ. Bact and Immun, 1, 1931, 405) From horse manure See Manual, 5th ed, 1939, 534 for a description of this organism

Flavobacterium desutiosum (Wright)
Bergey et al. (Baculius decutiosus (sec)
Wright, Memoirs Nat Acad Sec, 7, 1853,
443; not Baculius desutiosus MeBeth,
Soi Sci, 1, 1016, 450; Bacterium desutiosus and Bacterium decutiosus Chester,
Ann Rept Del Col Agr Exp Sta, 9,
1897, 107 and 133, Flavobacterium decutiosum Bergey et al., Manual., 1st ed., 1023,
114) From water Gibbons (Contrib
Canadian Biol. and Fish., 8, No 24, 1934,
338) found this species in fillets of haddock (Melanogrammus acelefants) See
Manual, 5th ed., 1939, 5th for a description of this oreanism

Flobobacterium flatescens (Pohl) Bergey et al. (Bacillus flatescens Pohl, Cent f Bakt, 11, 1892, 144; Bergey et al, Manual, 1st ed, 1923, 107) From water See Manual, 5th ed, 1939, 535 for a description of this organism

Flaiobacterium flacum (Fulirmann) Bergey et al. (Bacillus flavus Fulirmann, Cent f Bakt, II Abt., 19, 1907, 117, Manual, 1st ed., 1923, 101) From beer See Manual, 4th ed., 1934, 141 for a description of this organism

Flavobacterium gelatinum Sanborn (Jour Bact , 19, 1930, 376) From sea water

Flavobacterium halmephilum Elazari-Volcani (Studies on the microflora of the Dead Sca, Thesis, Hebrew Univ, Jerusalem, 1940, VIII and S.) From the Dead Sca A yellow halophilic species

Flatobacterium halophilum Bergey et al (Culture No 30 of Baraank-Pikowsky, Cent. f. Bakt., II Abt., 70, 1925, 373, Bergey et al., Manual, 3rd ed., 1930, 147.) From sea water. See Manual, 5th ed., 1939, 540 for a description of this organism

Flaubactersum lacunatum (Wright)
Bergey et al (Bacillus lacunatus
Wright, Memoirs Nat. Acad Scu., 7,
1805, 435, Bactersum lacunatus Chester,
Ann. Hept Del Col Agr L.P., Sta., 9,
1897, 110; Bergey et al , Manuul, 1st ed.,
1923, 117) From water See Manuul,
5th ed., 1939, 552 for a description of this
organism

Flarobacterium matzonii (Chester)
Bergey et al. (Species No. 46 of Conn,
Storrs Agr. Exper. Sta., 7th Ann.
Rept for 1894, 1895, 89; Bacillus matazonii (sie) Chester, Man. Determ.
Bact, 1901, 236; Bergey et al., Manual,
1st ed., 1923, 1977. From matzon, a
fermented milk from Armenia. See Manual, 5th ed., 1939, 536 for a description
of this oreanism.

Flavobacterium orale (Wright) Bergey et al (Bacillus oralis Wright, Memoirs Nat Acad Sci. 7, 1893, 435; Bacterium oralis Chester, Ann Rept. Del. Col. Agr Exp Sta, 9, 1897, 111; not Bacterium orale Migula, Syst d. Bakt., 2, 1900, 453, Bergey et al, Manual, 1st ed., 1923, 117) Tom water. See Manual, 5th ed., 1933, 551 for a description of this organism

Flatobacterium piteatum (Zimmermann) Bergey et al. (Bacillus piteatus Zmmermann, Bakt unserer Trink- u Nutzwasser, Cliemmitz, I, 1890, 51; not Bacillus piteatus Frankland and Frankland, Phil Trans. Roy Soc. London, 178, B, 1887, 273, Bergey et al., Manual, 1st ed., 1923, 103) From water Gramngstuve Non-motile See Manual, 5th ed., 1930, 322 for a description of this organism. See p 684.

Flatobacterium pruneaeum Sanborn. (Jour Bact, 19, 1930, 376) From sea water

Fluobacterum radiatum (Zimmermann) Bergey et al. (Bacillus radiatus Zimmermann, Bukt unserer Trinku Nutruässer, Chemnitz, 1, 1890, 55; Bacillus radiatus aquatilis Frankland and Frankland, Microorg, in Water, London, 1891, 458; Bergev et al., Manual. 1st ed., 1923, 101.) From water. See Manual, 5th ed., 1939, 531 for a description of this organism. Gram-variable. Slight motility of shorter rods.

Flavobacterium schrokikhii (II. Jensen) Bergey et al. (Sulpeter zerstörenden Bacillus, Schirokikh, Cent. f. Bakt., II Abt., 2, 1896, 205; Bacterium schirokikhi II. Jensen, ibid., 4, 1898, 409; Bacillus denitrificans Chester, Man. Determ. Bact., 1901, 274; Bergey et al., Manual, 1st ed., 1923, 100). From horse manure. See Manual, 5th ed., 1939, 527 for a description of this organism.

Flavobacterium stolanatum (Adametz and Wichmann) Bergev et al. (Bacillus stolonatus Adametz and Wichmann, Mitt. Oest. Versuchsstat. f. Brauerei u. Mālz., Wien, Heft 1, 1888, 884; Bacterium stolonatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 76; Bergey et al., Manual, 1st ed., 1923, 106.) See Manual, 5th ed., 1939, 535 for a description of this organism. From water.

Flavobacterium tremelloides (Tils) Bergey et al. (Bacillus tremelloides Tils. Ztschr. f. Hyg., 9, 1890, 292; Bacterium tremelloides Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 105, Bergey et al., Manual, 1st ed., 1923, 105.) From river water at Freiburg. Forms a yellow, slimy milk. See Manual, 5th ed., 1939, 532 for a description of this organism

Flavobacterium (Halobacterium) maris. mortui Elazari-Volcani. (Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ., Jerusalem, 1940, V and 48.) From the Dead Sca. This species and Flavobacterium (Halobacterium) halobium and Flavobacterium (Halobacterium) trapanicum are placed in a new subgenus of Flavobacterium named Halobacterium. All produce red pigment. The flagellation of these species was not determined. They may be polar flagellate, see Pseudomonas salinaria and P. cutirubra.

Flasobacterium (Halobacterium) halobium (Petter) Elazari-Volcani. (Microbe du rouge de morue, Le Dantec, Compt. rend. Soc. Biol., Paris, 58, 1902, 136; Bacillus halobius ruber Klebahn, Mitteil, a. d. Inst. f. allg. Bot. Hamburg, 4, 1919, 47; Bacterium halobium Petter, Over rood en andere bacterien van gesouten visch, Diss, Utrecht, 1932; Elazari-Volcani, Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ., Jerusalem, 1910, V and 59 ) From reddened salted codfish.

Flavobacterium (Halobacterium) trapanīcum (Petter) Elazari-Volcani. (Bacterium trapanicum Petter, Over rood en andere bacterien van gezouten visch, Diss., Utrecht, 1932; Clazari-Volcam, Studies on the Microflora of the Dead Sea, Thesis, Hebrew Univ. Jerusalem, 1940, V and 59.) From the Dead Sea.

#### FAMILY X. ENTEROBACTERIACEAE RAHN.

(Cent. f. Bakt., II Abt , 96, 1937, 280.)

Gram-negative straight rods. Motile with peritrichous flagella, or non-motile. Grow well on artificial media. All species attack glucose forming acid, or acid and visible gas (H; present). Characteristically nitrites are produced from nitrates (exceptions in Erwinia only). Antigenic composition is best described as a mosaic which results in serological interrelationships among the several genera, even extending to other families. Many animal parasites, and some plant parasites causing blights and soft trots. Frequently occur as asprophytes causing decomposition of plant materials containing carbohydrates.

Nore: Early attempts to develop a satisfactory basis for the recognition of species among the coliform-dysentery-typhoid group of bacteria are reviewed by Winslow, Kingler and Rothberg (Jour. Bact., 4, 1919, 429). These were largely based on differences in motility, production of indole, ability to liquely gelatin, and, more particularly, differences in the ability to ferment earthohydrates, especially such compounds as glucose, lactose, sucrose, dulcitol and salicin. The more recent attempts to express differences in species of coliform bacteria by means of the InIViC reaction are reviewed by Part (Amer. Jour Public Health, 28, 1936, 39) Bact. Rev., 5, 1939, 1), this cryptic symbol indicating the indole test, methyl red acid determination, acetylmethylcarbinol production (Voges-Proskauer reaction) and the utilization of salts of citric acid. Stuart, Griffin and Baker (Jour. Bact., 56, 1933, 391) and Griffin and Stuart (Jour. Bact., 40, 1940, 83) have applied these tests plus colloboss fermentation to a study of a long series of colutres.

Capsulated types of coliform bacteria are still placed in this edition of the MANUAL in a separate genus, Klebsella, although there is some question about the separation of these from the species in Excherchia and Aerobacter.

Meanwhile, the Kaufmann and White Antigenic Schema has been successfully applied to the recognition of scrological groups and types among submonellas and related organisms. The groupings recognized are outlined in the Salmonella Subcommittee Reports submitted to the 2nd and 3rd Congresses of Microbiology, 1908, 232. The INFR. 34, 1934, 335 and Proc. 3rd Internat Cong. for Microbiology, 1908, 323. The successful use of antigenic structure in this field has stimulated a study of the use of II and O antigens as means of elassifying the coliform group (Shurt, Baker, Zimmerman, Brown and Stone, Jour Bact., 49, 1949, 101) but this method of classifying the species of coliform bacteris has not proved particularly helpful as yet.

During this same period there has been an increasing appreciation of the closeness of the relationship between certain common chromogene bacterns (Serratio) and the coliform bacteria (Breed and Breed, Cent. I. Bakt., II Abt., 71, 1927, 435). Moreover, the close relationship between bacteria producing soft rots of laving vegatable and other plant tissue (now included in Erstina) and the coliform bacteria has become more evident in recent studies (Waldee, lows State Coll. Jour. Sci., 10, 1915, 435). Many intermediate types are found in rotting vegetable materials, these notting types having the ability to attack protopectin (Burkey, Iowa State Coll. Jour Ed., 3, 1928, 97) but not to cause soft rots of living plant tissue.

Borman, Stuart and Wheeler (Jour. Bact., 48, 1914, 351) have proposed a rearrangement of the species in the family Enterobacteriaecae which combines many forms that have previously been regarded as separate species, or even as belonging in separate genera. Only the future can determine which of all of these views best expresses the relationships of the bacteria belonging in the Family Enterobacteriaecae.—The Editors.

# Key to the tribes of family Enterobacteriaceae.

 Ferment lactose with the formation of acid and visible gas within 24 hours at 37°C or within 48 hours at 23° to 30°C. Some transitional forms produce acid and gas from lactose slowly.

Tribe I. Eschericheae, p. 441.

II. Plant parasites. Ferment lactose with formation of acid, or acid and visible gas Usually attack middle lamellar substance in plant tissues, causing soft rots. Tribe II. Erwineae, p. 463.

111. Ordinarily chromogenic producing a pink, red or orange-red pigment. Occasionally non-pigmented. Ferment glucose and lactose with formation of acid, or acid and visible gas.

Tribe III. Serrateae, p. 479.

- Lactose not fermented within 30 days either at 37°C or at 25° to 30°C. Urea decomposed within 48 hours.
  - V. Lactose rarely fermented within 30 days either at 37°C or at 25° to 30°C. Urea not decomposed within 48 hours.

Tribe V. Salmonelleae, p. 492.

TRIBE I ESCHERICHEAE BERGEY, BREED AND MURRAY.

(Preprint, Manual, 5th ed., October, 1938, vi.)

Ferment glucose and lactose with the formation of acid and visible gas within 24 hours at 37°C, or within 48 hours at 25° to 30°C. Some forms produce acid and gas from lactose slowly (occasionally not at all). Do not liquefy gelatin except slowly in Aerobacter cloacae

# Key to the genera of tribe Eschericheae.\*

- Acetylmethylcarbinol not produced. Methyl red test positive. Salts of citric acid may or may not be used as a sole source of carbon.
- Genus I. Escherichia, p. 441.

  II. Acetylmethylcarbinol produced. Methyl red test negative. Salts of citric acid used as sole source of carbon.

Genus II. Aerobacter, p. 453.

III. Acetylmethylcarbinol msy or may not be produced. Methyl red test variable. Salts of citric acid may or may not be used as sole source of carbon. Gas not as abundant as in previous genera. Capsulated forms from respiratory, intestinal and cenito-urinary regions.

Genus III. Klebsiella, p. 457.

# Genus I. Escherichia Castellans and Chalmerst.

(Castellani and Chalmers, Manual Trop Med., 3rd ed., 1919, 911; Colibacterium Orla-Jensen, Jour Bact, 6, 1921, 272; Colobactrum (in part) Borman, Stuart and

† Completely revised by Prof. M. W. Yale, New York State Experiment Station,

Geneva, New York, Nov , 1938, further revision, July, 1943.

<sup>\*</sup> Levine (Jour. Bact., 1, 1916, 153) was the first to show the inverse correlation between the methyl red and Voges-Proskauer tests and used these characters for the primary separation of the Escherichia coll section and the Aerobacter aerogenes section (Amer. Jour. Public Health. 7, 1917, 784).

Wheeler, Jour. Bact , 48, 1944, 357 ) Named for Theodor Escherich, who first isolated the type species

Short rods fermenting glucose and lactose with acid and gas production. Acetylmethylcarbinol is not produced Methyl red test positive. Carbon dioxide and
hydrogen produced in approximately equal volumes from glucose. Generally not
able to utilize uric acid as a sole source of nitrogen. Found in feces and is occasionally
pathogenic to man (colitis, cystitis, etc) It is, however, also widely distributed in
nature.

The type species is Escherichia coli (Migula) Castellani and Chalmers.

#### Key to the species of genus Escherichia.

- I Citric acid and salts of citric acid not utilized as sole source of carbon.
  A. Hydrogen sulfide not produced
  - 1. Escherichia coli.
- II Citric acid and salts of citric acid utilized as sole source of carbon.
  A Hydrogen sulfide produced.
  - Escherichta freundii.
  - B. Hydrogen sulfide not produced
- 3 Escherichia intermedium.
- Escherichia coli (Muzula) Castellani and Chalmers. (Bacterium coli commune Escherich. Die Darmbakterien des Neugeborenen und Sauglings, 1885, Bacillus escherichis Trevisan, I generi e le specie delle Batteriacee, 1889, 15, Bacillus coli communis Sternberg, Manual of Bacteriology, 1893, 439: Bacillus coli Migula, in Engler and Pranti, Naturlichen Pflanzenfam , 1, 1a, 1895, 27, Bacterium coli Lehmann and Neumann, Bakt Diag , I Aufl , 2, 1896, 221, Bacillus cols serus Durham, Jour Exp Med , 5, 1900. 371: Bacillus coli communis verus Durham, ibid, 353; Aerobacter coli Benerinck, Cent. f Bakt., II Abt., 6, 1900, 193, Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 941, Bacillus coli-communis Winslow, Kligler and Rothberg, Jour. Bact , 4, 1919, 483, Bacterium coli-communis Holland, Jour. Bact . 5. 1920, 217, Colobactrum coli Borman, Stuart and Wheeler, Jour Bact., 48, 1911, 358 ) From Latin colon, the large intestine

Nort Weldin (Iowa State Jour Sci., 1927, 121) considers the following identical with the above. Bacillus carreda Hügge, Die Mikroorganismen, 1886, 205 or more probably Brieger, Berlin

klin, Wochnschr., 1884, No. 14; Bacillus C. Booker, Trans Ninth Internat. Med. Congress, 5, 1887, 598; Bacillus schafferi von Freudenreich, Landw. Jahrh. d. Schweiz, 4, 1890, 17: Bacterium cavicida Chester, Ann Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 130; Bacterium schaffers Chester, 161d., 74. Bacillus musiclae septicus Matzuschita, Bakt, Diag. 1902: Bacillus communis Jackson, Jour. Inf. Dis. 8, 1911, 241, not Bacillus communis Migula, Syst. d. Bakt , 2, 1900, 725; Escherichia carreida Castellani and Chalmers, Manual of Trop, Med , 3rd ed., 1919, 942, Escherichia schaeffert Bergey et al., Manual, 1st ed., 1923, 196,

Oesterle (Cent. f Bakt., I Abt., Orig., 134, 1935, 115) has described a yellow stram Bacterium coli flaum, Parr (Proc. Soc Exp Biol. and Med., 55, 1937, 563) a golden-brown stram Bacterium aurescens (not Bacterium aurescens (not Bacterium aurescens Migula, Syst. d Bakt., 2, 1909, 160), and Tritisler (Jour. Bact., 53, 1937, 450) reddisherange strams which are regarded as pigmented varants of Echerichia coli.

Rods: Usually 0.5 by 1.0 to 3 0 microns, varying from almost exceed forms to long rods, occurring singly, in pairs and short chains. Motile or non-motile. Motile strains have peritrichous flagella. Not usually capsulated. Non-spore-forming. Gram-negative.

Gelatin colonies: Opaque, moist, grayish-white, entire.

Gelatin stab: Grayish-white, spreading, undulate. No liquefaction.

Agar colonies: Usually white, sometimes yellowish-white, rarely yellow, yellow-brown, golden-brown, reddishorange or red; entire to undulate, moist, homogeneous. Atypical forms occur frequently.

Agar slant: Usually white, sometimes yellowish-white, rarely yellow, yellowbrown, golden-brown, reddish-orange or red growth; moist, glistening, spreading.

Broth: Turbid, with heavy grayish sediment. No pellicle.

Litmus milk: Rapid acid formation with development of gas, usually coagulation, curd may or may not be broken up, no peptonization of the curd. Litmus may or may not be reduced.

Potato: Abundant, grayish to yellowish-brown, spreading.

Indole usually formed.

Nitrites produced from nitrates.

Blood agar plates: Different strains vary widely in their action, some being hemolytic (Buchgraber and Hilkó, Cent. f. Bakt., I Abt., Orig., 133, 1935, 449).

Heat resistance: Usually destroyed in 30 minutes at 60°C, but certain heat-resistant strains may withstand this exposure (Ayers and Johnson, Jour. Agr. Rs., 5, 1914, 401; Stark and Patterson, Jour. Dairy Sci., 19, 1936, 495).

Antigenic structure: An antigenically heterogeneous species.

Methyl red test positive (Clark and Lubs, Jour. Inf. Dis., 17, 1915, 160); Voges-Proskauer test negative (Durham, Jour. Exp. Med., 5, 1901, 373); inverse correlation between methyl red and Voges-Proskauer tests (Levine, Jour. Bact., 1, 1916, 153).

Citric acid and salts of citric acid not utilized as sole source of carbon (Koser, Jour. Bact., 8, 1923, 493).

Uric acid not utilized as sole source of

nitrogen (Koser, Jour. Inf. Dis., 23, 1918, 377); uracil utilized as sole source of nitrogen (Mitchell and Levine, Jour. Bact., 35, 1938, 19).

Gas ratio: Approximately equal volumes of carbon dioxide and hydrogen, ratio 1:1, produced from glucose (Harden and Walpole, Proc. Roy. Soc., Ser. B, 71, 1905, 399; Rogers, Clark and Davis, Jour Inf. Dis., 14, 1914, 4119.

ni. Dis., 14, 1914, 411 Catalase produced.

No H<sub>2</sub>S produced in peptone iron agar (Levine, Epstein and Vaughn, Amer-Jour. Public Health, 24, 1934, 505, Tittsler and Sandholzer, Amer. Jour. Public Health, 27, 1937, 1240). More sensitive indicators give positive tests for HS (Hunter and Weiss, Jour. Bact., 55, 1938, 20).

Trimethyleneglycol not produced from glycerol by anaerobic fermentation (Braak, Onderzoekingen over Vergisting van Glycerine, Thesis, Delft, 1923, 166; Werkman and Gillen, Jour. Bact., 23, 1932, 167).

Acid and gas from glucose, fructose, galactose, lactose, maltose, arabinose, xylose, rhamnose and mannitol. Sucrose, raffinose, salicin, esculin, dulcitol and glycerol may or may not be fermented. Variable fermentation of sucrose and salicin (Sherman and Wing, Jour. Bact, 55, 1937, 315; Tregoning and Poe, Jour. Bact., \$4, 1937, 473). Inulin, pectin and adonitol rarely fermented. starch, glycogen and inositol not fermented. Cellobiose (Jones and Wisc, Jour. Bact., 11, 1926, 359) and α-methylglucoside (Koser and Saunders, Jour. Bact., 24, 1932, 267) not fermented. Certain strains produce variants which ferment lactose slowly or not at all (Rennebaum, Jour. Bact., 50, 1935, 625). Some strains of slow-lactose-fermenters appear to be intermediate between the coliform and paratyphoid groups (Sandiford, Jour. Path. and Bact., 41, 1935, 77). See Twort (Proc. Royal Soc. London, 79, 1907, 329) for utilization of unusual glucosides; Dozois et al. (Jour. Bact., 30, 1935, 189 and 32, 1936, 499)

for utilization of certain sugar alcohols and their anhydrides; Pee and Klemme (Jour. Biol. Chem., 109, 1935, 43) for utilization of rare sugars See Winslow, Kligler and Rothberg (Jour. Bact., 4, 1919, 429) for review of literature relative to classification.

Fecal odor produced.

Aerobic, facultative.

Growth requirements Good growth on ordinary laboratory media Optimum growth temperature 30° to 37°C. Growth takes place at 10°C and at 45°C Gost produced from glucose at 45° to 46°C Eijkmann test postitive (Eijkmann, Cent. f Bakt., 1 Abt, Org., 57, 1904, 74. Perry and Hajna, Jour. Bact., 29, 1933, 419).

Source: From feces of infants.

Habitat: Normal inhabitant of the intestine of man and all vertebrates Widely distributed in nature. Frequently causes infections of the genitourinary tract. Invades the circulation in agonal staces of diseases

la Escherichia coli var. acidilactica (Topley and Wilson) Yale.

(Milchsaurebacterium, Hueppe, Mit. d. kais. Gesund . 2, 1884, 340, Bacellus acidi lactici Zopf, Die Spaltpilze, 1885, 87: not Bacterium acidi lactici Zopf, Die Spaltpilze, 1884, 60; Bacillus acili lactics I and II Grotenfelt, Fortschr. d Med., 7, 1889, 121; possibly also Bactersum acidi lactici I and II Grotenfelt, ıbıd , 123, Bacterium acidi lacticı Migula, in Engler and Prantl, Natürlichen Pflanzenfamilien, 1, 1a, 1895, 25; not Bacterrum acidi lactici Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. 2, 1896, 357; not Bacterium B, Peters, Bot. Zeitung, 47, 1889, 422); possibly Bacterium grotenfeldtis Migula, Syst. d. Bakt., 2, 1900, 40S, a synonym of Bacterium acids lactici I Grotenfelt; Bacillus acidilactici Jackson, Jour. Inf Dis , 8, 1911, 241; possibly Bacillus lacticus Mace, Traité pratique de bact., 1913, 452; not Bacillus lacticus Kruse, in Flügge, Die Mikroorganismen, £, 1896, 356; Bacterium dwodenale Ford, Studies from Victoria Hospital, Montreal, I, 1903, 17 (according to Perkins, Jour. Inf. Dis., 57, 1925, 247). Encapsulatus ecidi lactici Castellani and Chalmers, Manual of Trop Med., 1919, 934; Bacillus lactici-acidi Holland, Jour. Bact, 5, 1920, 218; Bacterium acudilactici Holland, stid.; (Encapsulata) Bacillus dwodenale Perkins, Jour. Inf. Dis., 57, 1925, 247; Escherichia acidilactici Bergey et al., Manual, 1st ed., 1923, 199; Bacterium colt var. acidi lactici Topley and Wilson, Princip. Bact. and Immun., 1, 1931, 446, Yale, in Manual, 5td., 1930, 339.

Identification: Includes strains of Escherichia coli which do not attack either sucrose or salicin. It is generally thought that Hueppe's cultures were contaminated with a spore-former.

Source: From milk.

1b Escherichia coli var. neapolitana (Topley and Wilson) Yale (Neapeler Emmerich, Bacterien, Deut. Wehnschr , 10, 1881, 209 , Bacillus neapolitanus Flügge, Die Mikroorganismen, 1886. 270, Bacterium neapolitanus Chester, Ann Rept. Del Col. Agr. Evp. Sta., 9, 1897, 138. Escherichia neapolitana Castellani and Chalmers, Man. Trop. Med., 3rd ed , 1919, 942; Bacterium cols var. neapolitanum Topley and Wilson, Princip. Bact. and Immun , 1, 1931, 416, Yale, in Manual, 5th ed , 1939, 393 )

Identification: Includes strains of Escherichia coli which ferment sucrose and salicin.

Source: From cholera patients or cadavers, originally thought to be the cause of cholera.

1c. Eicherichia coli var. communior (Topley and Wilson) Yale. (Bacillus coli communior Durham, Jour. Exp. Med., 5, 1930, 333; Bacillus communior Ford, Studies from Victoria Hosp, Montreal, 1, 1933, 17; Bacterium communior Jackson, Jour. Inf. Dis., 8, 1911, 211; Bacillus coli-communior Holland, Jour. Bact., 5, 1920, 217; Bacterium coli-communior 1920, 217; Bacterium coli-communior Holland, idem; Escherichia communior Bergey et al., Manual, 1st ed., 1923, 200; Bacterium celi var. communior Topley and Wilson, Princip, Bact, and Immun., 1, 1931, 416; Yale, in Manual, 5th ed., 1939, 293.)

Yale (Cornell Vet., 23, 1933, 306) regards Bacterium astheniae Dawson (15th Ann. Rpt., Bur. Anim. Ind., U.S.D.A., 1898, 329; Bacillus astheniae Winslow, Kligler and Rothberg, Jour. Bact., 4. 1919, 487; Escherichia astheniae Bergey et al., Manual, 1st ed., 1923, 205) as a synonym of Escherichia communior.

Identification: Includes strains of Escherichia coli which ferment sucrose but not salicin. Levine (Iowa Eng. Exp. Sta. Bul. 62, 1921, 38) recognizes a strain which ferments salicin

Escherichia freundii (Braak) Yale. (Bacterium freundi: Brank, Onderzoekingen over vergisting van glycerine. Thesis, Delft, 1928, 140; Citrobacter freundii Werkman and Gillen, Jour. Bact., 23, 1932, 176; Yale, in Manual, 5th ed., 1939, 394, Colobactrum freundii Borman, Stuart and Wheeler, Jour. Bact , 48, 1944, 358.) Named for A. Fround, who first observed that trimethyleneglycol was a product of fermentation (ISSI).

Minkewitsch (Ztschr. f. Hyg., 111, 1930, 180) proposed the name Bacterium coli citrororum for the intermediates but this name is not acceptable since it is a trinomial.

Werkman and Gillen (Jour. Bact , 23, 1932, 177) emended the description of Bacterium freundir, and created the genus Citrobacter The following species renamed by Werkman and Gillen are regarded as identical with Escherichia freundir Citrobacter album, Citrobacter decolorans. Citrobacter diversum and Citrobacter anindolicum

Tittsler and Sandholzer (Jour. Bact., 29, 1935, 349) and Carpenter and Fulton (Amer Jour. Pub. Health, 27, 1937, 822) suggest that the intermediates which

give a positive methyl red and a negative Voges-Proskauer test be allocated to the cenus Escherichia. Other strains are apparently more nearly related to the genus Acrobacter than to the genus Escherichia since they produce acetylmethylcarbinol. Barritt (Jour. Path. and Bact., 42, 1936, 441; 44, 1937, 679) has shown that some of the intermediates form traces of acetylmethylcarbinol which can be detected by the α-naphthol test, but not by the standard Voges-Proskauer test as described in the Manual of Methods for the Pure Culture Study of Bacteria (Soc. Amer. Bact., 1937, 17).

Rods: Short rods with rounded ends, occurring singly, in pairs and short chains. Motile or non-motile, Gramnegative.

Gelatin stab: Liquefaction by 4 out of 15 cultures (Werkman and Gillen, Jour. Bact., 23, 1932, 177). No liquefaction by any strains (Tittsler and Sandholzer, Jour. Bact., 29, 1935, 353; Carpenter and Pulton, Amer. Jour. Pub. Health, 27, 1937, 822).

Agar slant: Smooth, gray, shining. filiform and butyrous growth.

Litmus milk: Acid in 2 days; coagulation may or may not take place; no peptonization.

Potato: Abundant, yellowish-white growth.

Indole may or may not be formed (Werkman and Gillen, loc. cit.; Tittsler and Sandholzer, loc. cit.).

Nitrites produced from nitrates.

Methyl red test positive. Voges-Proskauer test negative (Koser, Jour Bact , 9, 1924, 59). Some strains give a positive methyl red and a positive Voges-Proskauer test (Parr. Jour. Bact., 36, 1938, 1).

Citric acid utilized as sole source of carbon; uric acid not utilized as the sole source of nitrogen (Koser, loc. cit.; Werkman and Gillen, loc. cit., 167).

Catalase produced.

Hydrogen sulfide produced in proteose peptone, ferrie citrate agar (Levine, Epstein and Vaughn, Amer Jour. Pub. Health, 24, 1934, 505; Tittsler and Sandholzer, Amer. Jour. Pub. Health, 27, 1937, 1240).

Trimethyleneglycol produced from glycerol by anaerobic fermentation (Braak, loc. cit., 146, Werkman and Gillen, loc. cit., 167).

Acid and gas from glucose, functose, gulactose, nathonose, xylose, rafinose, lactose, maltose, mannose, rhamose, trehalose, glycerol, manntol and sorbitol Sucrose, salicin, dulcitol, adonttol and nositol may or may not be fermented Cellobuse usually fermented while a methyl-glucoside may or may not be fermented (Tittsler and Sandholzer, loc ctt.; Carpenter and Fulton, loc ctt.). No acid or gas from amygdalın, devtrin, erythritol. elycosen, inulun or melezitose reythritol. elycosen, inulun or melezitose.

rythritol, glycogen, inulin or melezito: Acrobic, facultative.

Growth requirements Good growth on ordinary laboratory media. Optimum growth temperature 30° to 37°C Gas not produced in Eijkman test when carried out at 45° to 46°C (Levine, Epstein and Vaughn, loc. ctt.) No gras at 4°C (Wilson, Med Res. Council, London, Social Reut, Ser. 206, 1935, 165)

Habitat. Normally found in soil and water and to a varying degree in the intestinal canal of man and animals. Widely distributed in nature

3 Escherichia intermedium (Werkman and Gillen) Yaughn and Levine (Citrobacter intermedium Werkman and Gillen, Jour Baet, 23, 1932, 178; Vaughn and Levine, Jour. Baet, 44, 1942, 498)

Citrobacter glycologenes Werkman and Gillen (loc. cit.) is also regarded as a synonym of Escherichia intermedium Yaughn and Levine (loc. cit.) give a new description of Escherichia intermedium based on a study of 27 cultures

Rods: Short rods with rounded ends Occurring singly, in pairs and short chains in young nutrient agar or broth cultures Actively motile with peritirichous flagella or non-motile. Gram-negative. Gelatin stab: No liquefaction after 60 days at 20°C.

Agar slant: Smooth to wrinkled surface, grayish-white, abundant, raised and

butyrous growth.

Nutrient broth: Turbid with slight

ring at surface.

Litmus milk Acid, sometimes coagula-

tion and reduction, no proteolysis

Potato Growth abundant, white to

Levine's cosne-methylene blue agar: Well-solated colonies vary from 1 to 4 mm in size. No confluence of neighboring colonies. Colonies are slightly to moderately raised with surfaces varying from flat to convex and usually smooth and glistening but sometimes dull, rough and granular.

By transmitted light two types of colonies have been observed: (1) Colonies having almost the same appearance throughout but with a distinctly lighter center, the color being similar to the medium (2) Colonies having a dark brownish central area which diffuses out to a lighter margin.

By reflected light three types of colonies have been observed (1) Dark, button-like, concentrically ringed colonies possessing a strong, greenishmetallic sheen so characteristic for Eschtrichia coli. (2) Colonies with dark, purplish, wine-colored centers surrounded by a light pink zone. Some colonies are concentrically ringed. (3) Pink colonies with no suggestion of sheen but sometimes concentrically ringed.

Indole may or may not be formed

Nittites produced from nitrates Fermentation of glucose: The end products characteristic for the genus Escherichia are formed. Carbon dioxide and hydrogen gases are formed in approximately equimolar proportions (gas ratio 11) besides significant quantities of ethyl alcohol, and acetic, lactic and succinic acids with only traces of formile acid. Acetylmethylcarbinol and 2-3.

butylene glycol have not been found (Voges-Proskauer test negative).

(Voges-Proskauer test negative).
Salts of citric acid are utilized as a sole

source of carbon. Catalase produced.

Hydrogen sulfide not detected in proteose peptone ferric-citrate agar.

Acid or acid and gas produced from xylose, ambinose, rhamnose, glucose, fructose, mannose, galactose, lactose, maltose, trebalose and mannitol. No acid or gas from melezitose, amygdalin and erythritol. Sucrose, raffinose, celobiose, a-methyl-glucoside, adonitol, dulcitol, glycerol, inositol, sorbitol, starch, aesculin, salicin and sodium malonate may or may not be fermented. Aerobic, facultative.

Temperature requirements: Growth at 10°C and at 45° to 46°C. Optimum growth temperature 30° to 37°C. Gas not produced in Eijkman tests, although some cultures show growth at 45° to 46°C.

Salt tolerance: Most cultures ferment glucose in the presence of sodium chloride in a concentration of 6.0 to 70 per cent. A few cultures tolerate 8.0 per cent sodium chloride.

pH range: Optimum about pH 7.0. Growth occurs at pH 5.0 to pH 8.0.

Habitat: Normally found to a varying degree in soil, water and in the intestinal and of man and animals. Widely districted in nature.

Appendix: The following described species have been placed in Escherichia trimy belong hero:

Emilias alcalescens Ford. (Ford, Brains Imm the Royal Victoria Hosp, Mantral, I, (8), 1903, 37; also see Jour. Markett, Abrus, Lancet, 194, 1918, Markett, Abrus, Lancet, 194, 1918, W. Labratic Alexans Bergey et al., 11, 125, 202.) From feces.

nefustellani. (Cascal Abt., Orig., 65, nternasiaticus Sak-\$, 1893, 550; ani and Chalmers, Manual of Trop. Med., 3rd ed 1919, 940; Proteus asiaticus Bergey et al Manual, 1st ed., 1923, 211; Bacterium asiaticum Weldin and Levine, Abst. Bact., 1, 1923, 13.) From feces. Ferments lactose slowly or not at all.

Bacillus asiaticus mobilis Castellari (Valerie 21, Boycott, Jour. Hyg., 6, 1906, 33; Castellari, Ann. di Med., Nav. e Colon., 11, 1916, 453; Salmonella asiaticus mobilis Castellari and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 940; Bacterium palerici Weldin and Levine, Abet. Bact., 7, 1923, 13; Proteus valerici Berger et al., Manual, 1st ed., 1923, 211.) From foces. A motile variety which Alves (Jour. Path. and Bact., 44, 1937, 453) found to be identical with Bacillus pasialicus.

Bacillus chylogenes Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 62; also see Jour. Med. Res., 6, 1901, 219.) From feces.

Bacillus coli immobilis Kruse. (Kruse, in Flügge, Die Milroorganismen, 3 Auß, 2, 1896, 339; Bacterium coli immobilis Chester, Del. Agr. Exp. Sta., 9th Ann. Rept., 1897, 128; Enteroides entericus Castellani, Jour. Hyg., 7, 1907, 1; Bacillus schafferi MacConkey, Jour. Hyg., 9, 1903, 86; not Bacillus schafferi von Freudenreich, Landwirtschl. Jahrb. den Schweiz, 4, 1890, 17; Bacillus entericus Castellani and Chalmers, Manual of Trop. Med., 1st ed., 1910, 990; not Bacillus entericus Ford, Studies from Royal Victoria Hosp., Montreal, 1, (5), 1903, 40; Escherichia schaefferi Bergey et al., Manual, 1st ed., 1923, 196; Bacterium coli var. immobilis Winslow et al., Jour. Bact., 4, 1919, 486; Bacterium schafferi Weldin and Levine, Abst. Bact., 7, 1923, 13; not Bacterium schafferi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 74; Escherichia enterica Weldin, Iowa State Coll. Jour. Sci., 1, 1927, 134.) From feces. These were all described as non-motile variants of Escherischia coli (see Weldin, loc.

cit.)
Bacıllus coli mutabilis Neisser.

(Neisser, Cent. f. Bakt., I Abt. Ref. (Supp.), \$8, 1906, 98, Bacterium cols mutabile Massini, Arch f. Hyg . 61, 1907, 250: Escherichia coli mutabilis Castellani and Chalmers, Man. Trop Med. 3rd ed., 1919, 943: Escherichia coli-mutabile Deere et al., Jour. Bact . \$1, 1936, 625 ) From faces An unstable variant closely related to Escherichia cali characterized by irregular lactose fermentation When cultured on lactors inducator agar it appears not to ferment lectore. After some days, lactose-fermenting namilae appear growing on or out of the original colonies. Subcultures from these secondary colonies give typical lactose fermentation but subculture from the primary colony, avoiding contact with the papillae, gives delayed fermentation of lactose and when again plated will produce non-fermenting colonies on which fermenting papillae later appear

Bacillus gastricus Ford (Ford, Studies from the Royal Victoria Hosp, Montreal, I, (5), 1903, 58, also see Jour Med. Res., 6, 1901, 213; Escherichia gastrica Bergey et al, Manual, 1st ed.,

1923, 203 ) From feces.

Bacillus gruenthali Morgan, Ons gruenthaler Bacterium, Fischer, Zischi f Ilyg, 29, 1902, 417; Morgan, Brit Med Jour., f, 1905, 1257; Bacillus acidi lactici var. gruenthali Levine, Jour Bact, 3, 1918, 270; Bacterium acidiactici var. gruenthali Winslow, Kilgler and Rothberg, Jour. Bact., 4, 1919, 485; Escherichia gruenthali Castellani and Chalmers, Manual of Trop. Med., 1919, 912, Bacterium gruenthali Weldin and Levine, Abst. Bact., 5, 1923, 13) From feces.

Banilus thacus Ford. (Ford, Studies from the Royal Vetoria (Hosp., Montrea), 1, (5), 1903, 61; also see Jour Med Res., 6, 1901, 213, Escherichia thacus Bergey et al., Manual, 1st ed., 1923, 203, Profess thacus Bergey et al., Manual, 4th ed., 1931, 363.) From feces.

Bacillus infrequent Ford (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 42; also see Jour. Med. Res, 6, 1901, 219.) From feces.

Bacillus jejunales Ford. (Ford, Studies from the Royal Victoria Hosp, Mon-

leporus lethalus Sternberg, Manual of Bacteriology, 1893, 453; Bacterium leporis lethalus Chester, Ann. Rept. Del Col. Agr Exp. Sta. 9, 1897, 97; Aligula, Syst. Bakt. 2, 1900, 651; Eberthella leporis Bergey et al., Manual, 1st ed., 1923, 229; Etcherscha leporis Bergey et al., Manual, 2nd ed., 1925, 221.) From feces.

Bacillus para-gruenthali Castellani, (Castellani, 1914, quoted from Castellani and Chalmers, Ann. Past. Inst., 34, 1920, 614; Escherichia paragruenthali Castellani and Chalmers, Manual of Trop. Med, 3rd ed., 1919, 942; Bacterium, coli var. paragruenthali Weldın and Levine, Abst. Bact., 3, 1923, 13.) From feces. Weldin and Levine (Iowa State Coll. Jour. Sci. 1, 1926, 132) regard this species as identical with Bacillus gruenthali Morgan.

Bacillus plebeius Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 41; also see Jour. Med. Ros., 6, 1901, 213; Escherichia plebeia Bergey et al., Manual, 1st ed., 1923, 203.) From frees.

Bacillus subalcalescens Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 37, also see Jour. Med Res., 6, 1901, 217.) From feces.

Bacillus subgastricus Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, I, (5), 1903, 58; also see Jour. Med Res., 6, 1901, 219.) From feces.

Bacillus vekanda Castellani (Castellani, Jour. Trop. Med and Hyg., 20, 1917, 181; Enteroides relanda Castellani and Chalmers, Manual of Trop. Med, 3rd ed., 1919, 941; Bactersum retanda Weldin and Levine, Abst. Bact., 7, 1923, 13; Encherichia retanda Bergey et al., Manusi, 1st ed., 1923, 197.) From feces. Bacillus reticuls/prams Henrici. (Henrici, Arb. Bakt. Inst. Hochsch. Karlsruhe, I, 1894, 25; Escherichia vesiculiformans Bergey et al., Manual, 2nd ed., 1925, 222.) From cheese.

Bacterium chymogenes Ford. (Ford, Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 63; also see Jour. Med. Res., 6, 1901, 219.) From feces.

Bacterium coli alcaligenes Chiari and Loffler. (Cent f. Bakt., I Abt., Orig., 96, 1925, 95.) From feces.

Bacterium coli anindolicum Lembke (Lembke, Arch. f. Hyg., 26, 1896, 299; Bacillus anindolicum Chester, Man. Determ. Bact., 1901, 207; Escherichia anindolica Bergey et al., Manual, 3rd ed., 1930, 325.) From feces.

Bacterium coli imperfectum Roeleke. (Cent. f. Bakt, I Abt., Orig, 145, 1939, 109.) From feces Lactose not fermented.

Bacterium formicum Omelianski (Omelianski, Cent I. Bakt., II Abt., II, 1904, 184; Achromobacter formicum Bergey et al , Manual, 1st ed , 1923, 144, Escherichia formica Bergey et al., Manual, 2nd ed , 1925, 220.) From soil.

uan, Jun eu , 1923, 220.) From Son.

Bacterium galactophilum Ford. (Ford,
Studies from the Royal Victoria Hosp,
Montreal, 1, (5), 1903, 39, also see Jour.
Med. Res., 6, 1901, 217; Escherichia
galactophila Bergey et al., Manual, 1st
ed., 1923, 202) From feees.

Bacterium succinicum Sakaguchi and Tada (Cent. f. Bakt, II Abt, 101, 1940, 341.) From cheese

Bacterium uromutabile Koch (Cent. f. Bakt., I Abt., Orig., 133, 1935, 209)
From genito-urinary infections A non-lactose-fermenting variety that developed the ability to ferment lactose slowly.

Bacterium tesseulosum Henriei (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 37; Bacillus tesseulosus MacConkey, Jour Hyg, 9, 1909, 86, Escherichia tesseulosa Castellani and Chalmers, Man Trop. Med. 3rd ed., 1919, 912.) From cheese

Escherichia alba Schrire (Trans

Royal Soc. So. Africa, 17, 1928, 43.) From feces.

Escherichia brasiliensis Mello. (Sao Paulo Medico, Anno 10, 2, 1937, 11.) From feces.

Escherichia colofoetida (Castellani) Hauduroy et al. (Bacillus colofoetidus Castellani, Jour. Trop. Med and Ilys., 1930, 134; Hauduroy et al., Diet. d. Bact. Path., 1937, 226.) From feces.

Escherichia coloides (Castellani) Castellani and Chalmers. (Bacillus coloides var. A and Bacillus coloides var. B, Castellani; Castellani and Chalmers, Manual of Trop Med , 1919, 942 and 946.) From feces.

Escherichia colotropicalis (Castellani) Castellani and Chalmers (Bacillus colortropicalis Castellani, 1907; see Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 942 and 946) From fecces.

Escherichia ellingeri (Metalnikov and Chorine) Bergey et al (Coccobacillus ellingeri Metalnikov and Chorine, Ann. Inst. Past., 42, 1928, 1635; Bergey et al., Manual, 3rd ed., 1930, 330) Causes fatal infection in insects as Pyrausta nubilalis Hubn. (European corn borer) and Gelleria mellonella L. (bee moth). See Manual, 5th ed., 1939, 606 for a description of this species.

scription of this species.
Escherichia khartoumensis (Chalmers and Macdonald) Hauduroy et al. (Bacillus khartoumensis Chalmers and Macdonald, 1915; see Castellani and Chalmers, Manual of Trop. Med., 3rd ed.) 1919, 945; Enteroides khartoumensis Castellani and Chalmers, tbid., 941; Hauduroy et al., Diet. d. Baet. Path., 1939, 230) From feces.

Escherichia metacoli (Castellani) Castellani and Chalmers. (Bacillus metacoli Castellani, 1915, see Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 942 and 948.) From feces.

Escherichia metacoloides (Castellani) Castellamand Chalmers. (Bacillus metacoloides Castellani; see Castellani and (Thalmers, Manual of Trop. Med., 3rd ed., 1919, 942 and 950.) From feces.

Escherichia paradoxa (Toumanoff) Haudurov et al. (Colibacillus paradorus Toumanoff, Bull, Soc. Centr. de Méd. Vétér . 80, 1927. 367: Hauduroy et al , Diet. d. Baet. Path., 1937, 231 ) From foces.

Escherichia varaenterica (Castellani) Haudurov et al. (Bacillus pargentericus Castellani, Manual of Trop Med . 1st ed 1910. 991: Enteroides paraenterica Castellani and Chalmers, thid . 3rd ed . 1919, 941; Haudurov et al , Diet d Bact Path , 1937, 231.) From feces

Escherichia pauloensis Mello (Ass. Paulista de Medicina, 11, 1937, 73.) From faces

Escherichia vseudocoli (Castellani) Castellani and Chalmers (Bacellus pseudo-coli Castellani, Manual of Trop Med , 1st ed., 1910, 990, Castellant and Chalmers, Manual Trop Med , 3rd ed , 1919, 942.) From feces,

lani) Haudurov et al. (Bacillus pseudocoliformis Castellani, 1917; see Castellani and Chalmers, Manual of Trop Med . 3rd ed . 1919. 952; Hauduroy et al , Dict. d Bact. Path , 1937, 233.) From focos

Escherichia pseudo-coliformis (Castel

Escherichia pseudocoloides (Castellani)

Castellani and Chalmers, (Bacellus pseudocoloides Castellani, 1916; see Castellani and Chalmers. Manual of Trop. Med . 3rd ed . 1919, 954; thid 912. Bacterium pseudo-coloides Weldin and Levine. Abst Bact., 7, 1923, 13.) From fooos

Escherichia pseudocoscoroba Castellani and Chalmers. (Bacillus coscoroba Mac-Conkey, Jour Hyg , 6, 1906, 570; not Bacillus coscoroba Trétrop, Ann. Inst. Past . 14. 1900, 224; Bacterium coscorobae Bergey and Deeban, Jour. Med. Res. 19, 1908, 182, Castellani and Chalmers Man Trop Med , 3rd ed., 1919, 912; Bacillus communior var. coscoroba Winslow. Kligler and Rothberg, Jour. Bact . 4. 1919. 486, Escherichia coscoroba Weldin, Iona State Coll. Jour. Sci. 1. 1926. 139) From feces and sewage. This organism described by MacConkey is quite different from the organism described by Trétrop (see Pasteurella appendix)

Escherichia pseudodusenteriae Bergey et al (Bacterium pseudodysenteriae Kruse, Deutsche Med Wehnschr., 27. 1901, 386, Bergey et al , Manual, 1st ed 1923, 198.) From feces of normal persons and of dysentery patients

#### Genus II. Aerobacter Benerinch .

(Beijerinck, Cent. f. Bakt., H. Abt., 6, 1900, 193, Aerogenesbacterium Orla-Jensen Jour. Bact., 6, 1921, 272, Colobactrum (in part) Borman, Stuart and Wheeler, Jour. Bact , 48, 1944, 357 ) From Latin, sir or gas, and rod

Short rods, fermenting glucose and lactose with acid and gas production Methyl red test negative. Voces-Proskaper test positive. Form two or more times as much carbon dioxide as hydrogen from glucose, trimethyleneglycol not produced from glycerol by anaerobic fermentation, citric acid and salts of citric acid utilized as sole source of earbon. Grow readily on ordinary media. Facultative anaerobes Widely distributed in nature

The type species is Aerobacter aerogenes (Kruse) Beijerinek

Norma Pillater (t . T. C. D. at 1011 197) found the formation of

Levine (Amer Jour Pub Health, 7, 1917, 781) who reports that the two characters do not correlate perfectly Griffin and Stuart (Jour Bact., 40, 1940, 93ff.) find a similar correlation of characters but feel that because these characters do not correlate perfeetly, it would be better to combine the two species into a single species

. Completely revised by Prof. M. W. Yale, New York State Experiment Station. Geneva, New York, Nov., 1938; further revision, July, 1943.

## Key to the species of genus Aerobacter.

- I. Glycerol fermented with acid and gas.
  - A. Gelatin not liquefied (rarely liquefied).
  - 1. Aerobacter aerogenes.
    Glycerol fermented with no visible gas.
- Glycerol fermented with no visible gas.
   A. Gelatin liquefied.

1. Aerobacter aerogenes (Kruse) Beijerinck. (Bacterium lactis aerogenes Escherich, Fortschr. d. Med., 3, 1885, 515; Bacterium lactis Baginsky, Ztschr. f. phys. Chem., 12, 1888, 437; not Bacterium lactis Lister, Quart. Jour. Micro. Sci., 13. 1873, 380: Bacterium aceticum Baginsky, ibid.; Bacillus lactantium Trevisan, I generi e le specie delle Batteriacce, 1889, 15; Bacillus lactis aerogenes Sternberg, Manual of Bacteriology, 1893, 447; Bacillus aerogenes Kruse, in Flügge, Die Mikroorganismen, 2, 1896, 340; not Bacillus aerogenes Miller, Deutsche med. Wchnschr., 12, 1886, 119; Bacterium aerogenes Chester, Del. Agr. Exp. Sta., 9th Ann. Rept., 1897, 53; not Bacterium aerogenes Miller, loc. cit.; Beijerinck, Arch, néerl, d. sci. exact, et nat., 4, 1900, 1; Encapsulatus lactis-aerogenes Castellani and Chalmers, Manual of Trop. Med., 1919, 934, (Encapsulata) Bacillus aerogenes Perkins, Jour. Inf. Dis., 57, 1925. 254; Colobactrum aerogenes Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 358.) From Latin, gas-producing.

Rods: 0.5 to 0.8 by 1.0 to 20 microns, occurring singly. Frequently capsulated. (A variety showing a transverse arrangement of the capsule has been named Aerobacter transcapsulatus by Thompson, Jour. Bact., 28, 1934, 41.)
Usually non-motile. Gram-negative.

Gelatin colonies: Thick, porcelainwhite, opaque, moist, smooth, entire. Gelatin stab: Thick, spreading, white, opaque surface growth. No liquefaction.

Agar colonies: Thick, white, raised, moist, smooth, entire. More convex than colonies of Escherichia coli and often mucoid.

# 2. Aerobacter cloacae.

Agar slant: Abundant, thick, white, moist, glistening, spreading growth. Broth: Turbid, with pellicle and abun-

dant sediment.

Litmus milk: Acid with coagulation. No peptonization.

Potato: Thick, yellowish-white to yellowish-brown, spreading with nodular outgrowths over the surface.

Indole may or may not be formed (Ford, Studies from the Royal Victoria Hospital, Montreal, 1, 1901-1903, 16; Bardsley, Jour. Hyg. (Eng.), 34, 1934, 33; Wilson, Med. Res. Council, London, Spec. Rept. Ser. 206, 1935, 161).

Nitrites produced from nitrates.

Methyl red test negative (Clark and Lubs, Jour. Inf. Dis., 17, 1915, 160); Voges-ProSauer test positive (Durham, Jour. Exp. Med., δ, 1901, 373); inverse correlation between methyl red and Voges-Proskauer tests (Levine, Jour. Bact., 1, 1916, 183).

Citric acid and salts of citric acid utilized as sole source of carbon (Koser, Jour. Bact., 8, 1923, 493).

Uric acid utilized as sole source of nitrogen (Koser, Jour. Inf. Dis, 23, 1918, 377).

Gas ratio: Two or more volumes of carbon dioxide to one of hydrogen formed from glucose (Harden and Walpole, Proc. Roy. Soc. Series B, 77, 1905, 399; Rogers, Clark and Davis, Jour. Inf. Dis., 14, 1914, 411).

Catalase produced.

Hydrogen sulfide not produced in pertone iron agar (Levine, Epstein and Yaughn, Amer. Jour. Pub. Heatth, 24, 1934, 505; Tittsler and Sandholter, Amer. Jour. Pub. Health, 27, 1937, 1230). More sensitive indicators give positive tests for hydrogen sulfide (Hunter and Weiss, Jour. Bact., \$5, 1938, 20).

Trimethyleneglycol not produced from glycerol by anaerobic fermentation (Braak, Onderzoekingen over Vergusting van Glycerine, Thesis, Delft, 1928, 212; Werkman and Gillen, Jour. Bact, £5, 1932, 167).

Sodium hippurate hydrolyzed (Hajna and Damon, Amer. Jour. Hyg., 19, 1934, 545).

Acid and gas from glucose, galactose, lactose, fructose, arabinose, maltose, raffinose, cellobiose, salicin, esculin, starch, dextrin, glycerol, mannitol, sorbitol and inositol, e-methyl-glucoside usually fermented (Koser and Saunders, Jour. Bact., 24, 1032, 267). Sucrose, inulin, dulcitol and adonitol may or may not be fermented. Protopectin not fermented. Variable fermentation of sucrose and mannitol (Sherman and Wing, Jour Bact., 55, 1937, 315).

Aerobic, facultative

Aeronic, lacultative
Growth requirements: Good growth on
ordinary laboratory media. Optimum
growth temperature about 30°C. Grows
better at temperatures below 30°C than
does Leskerichia coli. Usually destroyed
in 30 minutes at 60°C, but certain heatresistant strains may withstand this
exposure (Ayers and Johnson, Jour Agr
Res, 8, 1914, 401; Stark and Patterson,
Jour. Dairy Sci., 19, 1936, 495). Gas
not produced in Eijkmann test when
carried out at 45° to 46°C (Lukmann,
Cent. f. Bakt, I Abt., Orig., 57, 1964,
74; Levine, Epstein and Vaughn, Amer.
Jour. Pub. Health, 28, 1934, 605)

Habitat: Normally found on grains and plants and to a varying degree in the intestinal canal of man and animals. Widely distributed in nature.

2. Aerobacter cloacae (Jordan) Bergey et al. (Bacillus cloacae Jordan, Rept. Mass. State Bd. of Health, Part II, 1890, 830; Bacterium cloacae Lehmann and Neumann, Bakt. Diag. 1 Aufl., £, 1896, 239, Bacillus lactic cloacae Conn. Esten and Stocking, Storrs Agr. Evp. Sta., Conn., 18th Ann. Rept for 1905, 1805 Cloaca cloacae Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 938; Bergey et al., Manual, 1st ed., 1923, 207.) From Latin cloaca, sower.

The following are also regarded as identical with Aerobater cloacus: Aerobater cloacus: Aerobater laughatens Grimes and Hennerty, Sci. Proc. Royal Dublin Society, (N. S.) 29, 1931, 93; not Aerobater thuguatiens Beyerinck, Cent. f. Bakt, II Abt., 6, 1900, 199 (monotrichous); Bacullus levans Wolffin, Arch. f. Hyg., 27, 1894, 279 and Lehmann, Cent. f. Bakt., 15, 1891, 350 (Bacterium levans Lehmann and Neumann, Bakt. Diag, 1 Aufl., 2, 1806, 235; Cloaca Levans Castellani and Chalmers, Man Trop. Med, 3rd ed., 1910, 938; Aerobacter levans Bergey et al., Manual, 1st ed., 1923, 208).

Rods 0.5 to 1.0 by 1.0 to 2.0 microns, occurring singly. Usually motile possessing peritrichous flagella. Not capsulated Gram-necative.

Gelatin colonies: Thin, circular, bluish, translucent.

Gelatin stab: Slow liquefaction. Liquefying power sometimes lost (Kligler, Jour, Inf. Dis., 15, 1914, 199).

Agar colonies: Circular, thick, opaque with white center, entire.

Agar slant: Porcelain-white, smooth, . glistening, spreading growth,

Broth: Turbid, with thin pellicle.
Litmus milk: Acid, coagulation, gas,

Potato: Growth yellowish, moist, glistening.

Indole not formed (Levine, Epstein and Vaughn, loc. cit.; Wilson, Med. Res. Council, London, Spec. Rept. Ser. 206, 1935, 161). Nitrites produced from nitrates.

Methyl red test negative; Voges-Pros-

Citric acid and salts of citric acid utilized as sole source of carbon (Koser, Jour. Bact., 8, 1023, 493).

Uric acid utilized as sole source of

nitrogen (Koser, Jour. Inf. Dis , 23, 1918, 377).

Gas ratio: Glucose fermented with at least two volumes of carbon dioxide to one of hydrogen (Rogers, Clark and Davis, Jour. Inf. Dis., 14, 1914, 411).

Catalase produced.

Hydrogen sulfide not produced in peptone iron agar (Levine, Epstein and Vaughn, Amer Jour. Pub Health, 24. 1934, 505).

Sodium hippurate not hydrolyzed (Hajna and Damon, Amer. Jour. Hyg., 19, 1934, 545).

Acid and gas from glucose, fructose, galactose, arabinose, xvlose, lactose, maltose, raffinose, dextrin, salicin, trehalose, mannitol, sorbitol, cellobiose and a-methyl-glucoside. Sucrose usually fermented. Inulin, esculin, starch, dulcitol, rhamnose and protopectin not attacked. Glycerol fermented with no visible gas (Kligler, loc cit , 187; Levine, Amer. Jour. Pub. Health, 7, 1917, 784). Starch rarely fermented (Levine, 1bid.). See Winslow, Kligler and Rothberg, Jour. Bact , 4, 1919, 429 for review of literature.

Fecal odor produced.

Aerobic, facultative.

Growth requirements. Good growth on ordinary laboratory media. Optimum growth temperature 30° to 37°C. Gas not produced in Eilkmann test when carried out at 45° to 46°C (Levine, Epstein and Vaughn, loc cit.).

Habitat · Found in human and animal feces, sewage, soil and water.

Appendix: The following described species have been placed in Aerobacter or may belong here:

Actinobacter polymorphus Duclaux (Duclaux, Ann. Inst Nat. Agron., 5, 1882, 110; Bacıllus actinobacter Migula, Syst d Bakt , 2, 1900, 689 ) Causes swelling of cheese. Possibly this was Aerobacter cloacae.

Aerobacter chinense Bergey et al. (Bacıllus capsulatus chinensis Hamilton, Cent. f. Bakt, II Abt., 4, 1898, 230; Bacterium chinense Migula, Syst. d. Bakt., 2, 1900, 357; Bergey et al., Manual. 1st ed . 1923, 207.) From India ink.

Acrobacter decolorans Burkey. (lows State Coll. Jour. Sci., 3, 1928, 77.) From rotted potato and hav infusions.

Aerobacter diversum Burkey. State Coll. Jour. Sci., 3, 1928, 77.) From

Aerobacter faeni Burkey, (Iowa State Coll. Jour. Sci., 3, 1928, 77.) From hay infusions

Aerobacter hibernicum Grimes and Hennerty. (Sci. Proc. Royal Dublin Society, (N.S.) 20, 1931, 92,) From butter.

Aerobacter leporis Botta. (Giorn. Batteriol, e Immunol , 23, 1939, 217.) From liver abscess in a rabbit.

Aerobacter melezitovorum Burkey. (Iowa State Coll. Jour. Sci., 3, 1928, 77.) From soil.

pectinovorum Burley. Acrobacter (Iowa State Coll. Jour. Sci. 3, 1928, 77.) From creek water.

Acrobacter oxytocum (Trevisan) Bergey et al. (Bacillus oxylocus perniciosus Flugge, Die Mikroorganismen, 1886, 268; Bacillus oxylocus Trevisan, I generi e le specie delle Batteriacee, 1889, 17, Bacterium oxylocus perniciosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sts., 9, 1897, 139; Bacterium oxytocum Migula, Syst. d. Bakt , 2, 1900, 394; Escherichia oxytocus Castellani and Chalmers, Manual of Trop. Med., 3rd ed., 1919, 942; Bergey et al., Manual, 1st ed., 1923, 206) From old milk.

Mello. Aerobacter paraoxy!ocum (Jorn. Dos Clinicos, No. 15, 1937.) From a dental abscess.

Bacillus aceris Edson and Carpenter (Edson and Carpenter, Vermont Agr. Exp Sta. Bull. 167, 1912, 475; Achromobacter acerss Bergey et al , Manual, 4th ed., 1934, 218.) From slimy maple sap See Manual, 5th ed., 1939, 506 for a description of this organism Identified by Fabian (Ind. and Eng. Chem, 27, 1935, 349) as Aerobacter aerogenes.

Bacillus aromaticus Pammel (Pammel, Bull No. 21, Iowa Agr Exper Sta , 1893, 792; Pammel and Pammel, Cent f Bakt., II Abt , 2, 1896, 633; Bacterium aromaticus Chester, Ann Rept Del Col Agr Exp. Sta , 9, 1807, 190, Flauconcterium aromaticum Bergey et al , Manual, 1st ed., 1923, 103) From cabbage Used as a starter for cheese making Acul and gas from glucose and sucrose See Manual, 5th ed., 1939, 533 for a description of this aromaticum.

Bacillus guillcheau a, b and c, von Freudenreich (Ann de Micrographie, 2, 1890, 353.) From mastitis milk Culture a may well have been Aerobacter aerogenes, b appears to have been A cloacae while c was a mucoid variant (see Sternberr, Man, of Beat, 1893, 273).

Bacillus subcloacae Ford (Studies from the Royal Victoria Hosp, Montreal, 1, (5), 1903, 60; also see Ford, Jour Med Res. 6, 1901, 213) From feces

Bacterium liquefaciens Ford (Studies from the Royal Victoris Hosp, Montreal, 1, (3), 1903, 59; also see Ford, Jour Med Res, 6, 1901, 215) From feces While Ford regards this species as identical with Bactilus Inquefaciens Lisenberg, neither is adequately described and they differ in important characters. The same holds truo for Bactilus Inquefaciens.

Fuller and Johnson, Jour. Exp Med.,

Bacterium mergaritaceum Migula. (Perlschnurbacillus, Maschek, Bakteriol. Untersuch. d. Leitmeritz Trinknasser, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 422 and 1059) From water. Possibly identical with Aerobacter aero-

Bacterium subliquefaciens Ford. (Studies from the Royal Victoria Hosp, Montreal, 1, (5), 1903, 59; also see Ford, Jour Med. Res, 6, 1901, 219.) From feces

Bacterum zeee Comes. (Bacterual Disease of Corn, Burrill, Ill. Agr. Exp. Sta Bull. 6, 1889, 164, Comes, Crittogamia Agraria, 1, 1891, 500; Bacillus secalis Ludwig, Lehrbuch der niederen Kryptogamen, 1852, 95, Bacillus zeee Russell, Bacteria in their relation to vegetable tissue, Thesis, Johns Hopkins Univ. Baltimore, 1882, 36) Prom corn blight. Moore (Agrie Sci. 8, 1891, 368) identified a culture received from Burril as Bacillus closeca Jordan.

Burkey (Iona State College Jour. Set, 5, 1928, 77) described five species (Aerobacter motologenes, Aerobacter motorium, Aerobacter mitificans, Aerobacter salicumotorium and Aerobacter pseudoprotosum which are regarded as varieties of Aerobacter calores.

# Genus III Klebstella Treusan.\*

(Trevisan, Atti della accad Fisio-Medico-Statistica in Milano, Ser 4, 5, 1885, 105; Callynmadobacterium Aragão and Vianno, Mem Inst. Oswaldo Cruz, 4, 1912, 222; Encapsulatus Castellam and Chalmers, Man Trop. Med., 3rd ed., 1919, 931.) Named for Edwin Klebs (1831-1913), early German bacteriologist

Short rods, somewhat plump with rounded ends, mostly occurring singly. Encapsulated in the mucoid phase Non motile Gram-negative. Fermentation reactions are highly armable but usually a number of carbohydrates are fermented. Nitrites are produced from mitrates Acrobic, growing well on ordinary culture media. Encountered frequently in the respiratory, intestinal and genuto-urinary tracts of man, but may be reolated from a variety of animals and materials.

The type species is Klebstella pucumoniae (Schroeter) Trevisan.

Bearranged by Prof. M. W. Yale, New York State Experiment Station, Geneva, New York, Nov., 1935, further revision by Dr. O. B. Chapman, Syrieuse Medical College, Syrause, New York, December, 1915.

 Kiebsiella pneumoniae (Schroeter) Trevisan. (Pneumoniecoccus, Friedlaender, Arch. f. Path. Anat., 87, 1882, 319; Bacterium pneumonie crouposae Zopf, Die Spaltpilze, 3 Aufl., 1885, 66; Klebsiella crouposa Trevisan, Atti della Accad. Fisio-Medico-Statistica in Milano, Ser. 4, 3, 1885, 105; Hyalococcus pneumoniae Schroeter, in Cohn, Kryptogamen Flora von Schlesien, 3(1), 1886, 152; Bacillus pneumoniae Flügge, Die Mikroorganismen, 2 Aufl., 1886, 204; Trevisan, Rend. d. R. Istit. Lombardo, Ser. 2, 20, 1887, 91; Klebsiella friedlanderi Trevisan, I generi e le specie delle Batteriacec, 1889, 26; Bacillus mucosus capsulatus Paulsen, Mittheil. f. d. Verein Schleswig-Holsteiner Aerzte. 2, 1803. No. 7; Bacterium pneumoniae Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 200; Bacterium pneumonicum Migula, Syst d Bakt., 2, 1900, 350; Bacillus friedlanderi Mace, Traité Pratique de Bact., 4th ed., 1901, 771; Encapsulatus pneumoniae Castellani and Chalmers. Man. Trop. Med., 3rd ed., 1919, 931; friedlanderi Coccobacillus Lemaire, Précis Parasitol, Hum., 5th ed , 1921, 20; Proteus pneumoniae Weldin, Iowa State Coll. Jour. Sci., 1, 1926, 149; Bacterium friedlander Weldin, idem; Bacillus mucosus-capsulatus Mason and Beattie, Arch. of Internal Med., 42, 1928, 331.) From Greek, of pneumonia.

Rods. 0.3 to 0.5 by 5.0 microns, with rounded ends, often four to five times as long as broad, occurring singly and in pairs. Encagalated Non-motile

Gram-negative.

Gelatin colonies: Dirty-white, smooth, opaque, entire, slightly raised.

Gelatin stab Dirty-white surface growth. Filiform growth in stab. No liquefaction. Gas bubbles

Agar colonies: White, shiny, convex, smooth, glistening, entire.

Agar slant: Slimy, white, somewhat translucent, raised growth.

Broth. Turbid, with thick ring or film. Litmus milk: Variable. Potato: Yellowish, slimy, raised growth. Gas is formed.

Nitrites produced from nitrates.

Indole variable, usually not formed. Fermentation of carbohydrates highly variable. Acid and gas may be formed from glucose, lactose, sucrose, fructose, galactose, malitose, mannitol and inositol. Methyl red test variable.

Acetylmethylcarbinol production variable.

Blood agar: Usually no hemolysis.

Utilization of citrate as a sole source of carbon variable.

Aerobic, facultative.

Optimum temperature 37°C.

Common name: Friedländer's pneumobacillus.

Source: Originally isolated from sputum in pneumonia.

Habitat: Associated with infections of the respiratory, intestinal and genitourinary tracts of man. Encountered in infections of animals and may be isolated from a wide variety of sources.

Note: The difficulty experienced in distinguishing members of this genus from those of Escherichia and Aerobacter is recognized. The members of these three genera exist in at least three growth phases, mucoid (capsulated), smooth and rough.

Working with the mucoid phase of Klebsiella, Julianelle (Jour. Erp. Med, 44, 1926, 113, 683, 735, 58, 1930, 539) described three scrological types, A, B and C on the basis of capsular specific polysaccharides. There is evidence that other types exist. The presence of a generic specific somatic antigen pottern has not been definitely accepted.

Appendix: The following organisms may be placed in Klebsiella. The evidence for differentiating them into distinct species is so meagre that for the present it may be better to consider them as varieties of Klebsiella gneumonice.

Klebsiella adanti Hauduroy et al.

(Dict. d. Bact. Path., 1937, 260.) From a case of pyelocystitis

Klebsiella capsulata (Sternberg) Bersey et al. (Kapselbacillus, Pfeifler, Ztschr. f. Hyg., 6, 1889, 145, Bacillus capsulatus Sternberg, Manual of Bact, 1893, 431; Bacterium capsulatum Migula, Syst d. Bakt., 2, 1900, 349, Encapsulatus pferfieri Bergey et al., Manual, 1st ed., 1923, 239; Bergey et al., Manual, 2nd ed., 1925, 265.) From purulent evudate from stompach of a guinea pic

Klebsiella crassa Trevisan (Bacillus sputigenus crassus Kreibohm, Inaug Diss., Göttingen, 1889; abst ın Cent. I. Bakt., 7, 1890, 313; Bacillus crassus sputigenus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 200; Trevisan, I generi e le specie delle Batteriacee, 1889, 25; Bacterium crassus Chester, Ann. Rept. Del. Col. Agr. Exp Sts., 9, 1897, 88; Bacterium crassum Chester, Man. Determ. Bact., 1901, 151) From sputum.

Klebsiella cuniculi Hauduroy et al (Bactilus capsulatus pyaemuse cunculii Koppinayi, Ztschr f. Tiermed, 11. 1907, 429; Hauduroy et al, Diet d. Bact Path., 1937, 262.) From pleuroperacrátits in a rabbit.

Klebstella genitalium (Dimock and Edwards) Hauduroy et al (Encapsulatus genitalium Dimock and Edwards, Jour. Amer. Veter. Assoc., 70, 1927, 469; Hauduroy et al, Diet. d. Bact Path, 1937, 294.) From infections in the genito-urinary organs of mares

Kilobiella granulomatis (Aragão and Vianua) Bergey et al. (Calymmatobacternum granulomatis Aragão and Vianua, Mem. do Inst. Osvaldo Cruz, Ro de Janero, 4, 1912, 211; Encapsulatus ingunalis Bergey et al., Manual, 1st ed., 1923, 238; Bergey et al., Manual, 2nd ed., 1925, 204.) From granuloma inguinale.

Klebstella ozgenge (Abel) Berrey et al (Racillus mucasus organae Abel. Cent. f. Bakt., 13, 1893, 167: Bacillus ezgenge Abel. 1bid., 172; not Bacillus ozaenae Migula, Syst. d Bakt., 2, 1900. 645. 662. Bacillus cansulatus mucasus Fasching, Sitzesber, Wien, Akad., III Abt., 100, 1891 (Bacterium cansulatus mucosus Chester, Ann Rept. Del. Col. Apr. Exp. Sta., 9, 1897, 130: Bacterium faschinoii Migula, Syst. d. Bakt., 2, 1900. 355: Bacillus capsulatus-mucosus Holland Jour. Bact . 5. 1920, 217: Bacterium mucosum capsulatum Holland, ibid. Racterium mucosum-capsulatum Holland thid 217) Racterium organae Lehmann and Neumann, Bakt, Diag. 1 Aufl . 2. 1896, 201: Bacterium mucosus ozaena Chester, Ann. Rept. Del. Col. Agr. Exp. Sta . 9, 1897, 138; Encansulate ozenae Bergev et al., Manual, 1st ed., 1923, 240; Bergey et al., Manual, 2nd ed., 1925, 266.) From cases of ozena,

Klebstella paralytica Cahn, Wallace and Thomas. (Wallace, Lyell, Thomas, Alvun and Cahn, Proc. Soc. Exp. Biol., 52, 1932, 1905; Cahn, Wallace and Thomas, Science, 76, 1932, 385; Wallace, Cahn and Thomas, Jour. Int. Dis., 63, 1933, 385, Klebstella alcis Haudurey et al, Diet d. Bact. Path., 1937, 200.) From intestine of tick (Dermacentor albiptectus) and thought to be the cause of teck paralysis of moose.

Klebstella rhinoselerometis Trevisan. (Rhinoseleromabacillus, v. Frisch, Wien. med Wehnechr, 1882; Cornil, Frogrès Medical, 1883; Trevisan, Rend. d. R Istit Lombardo, Ser. 2, 90, 1887, 93; Bacterium rhinoseleromatis Migula, Syst. d. Bakt. 2, 1900, 322; Juncierium nasalis Chester, Man. Determ. Bact., 1901, 131; Bacillus rhinoseleromatis Winslow, Kilgler and Rothberg, Jour. Bact., 4, 1919, 491.) From cases of rhinoseleroma. \*Appendix I. Tribe Eschericheae: Borman, Wheeler and Stuart (Jour. Bact., 48, 1944, 361) place coliform-like bacteria that are slow lactose-fermenters in a separate genus Paracolobactrum as follows:

# Genus A. Paracolobactrum Borman, Stuart and Wheeler.

(Paracolibacille, Widal and Nobecourt, Semaine Méd., 17, 1897, 285; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361.)

Short rods characterized by consistently delayed fermentation of lactose (occasionally negative). Glucose is fermented with formation of visible gas. Certain forms attack carbohydrates characteristically at 20° to 30°C but not at 37°C. Antigene relationships to other genera in the family are common, even with respect to major antigens.

The type species is Paracolobactrum aerogenoides Borman, Stuart and Wheeler.

Key to the species of genus Paracolobactrum.

- I. Acetylmethylcarbinol produced.
- Acetylmethylcarbinol not produced.
   A. Citric acid utilized as a sole source of carbon.
  - 9
  - B. Citric acid not utilized as a sole source of carbon,
     3. Paracolobactrum coliforme.
- Paracolobactrum aerogenoides Borman, Stuart and Wheeler. (Para-aerogenes, Stuart, Wheeler, Rustiguan and Zimmerman, Jour Bact., 45, 1943, 117; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361) Lattnized, resembling aerogenes.

Characters as for Aerobacter aerogenes and Aerobacter cloacae except for consistently delayed fermentation of lactose. Source From human gastroenteritis. Habitat Surface water, soils, grains,

Habitat Surface water, soils, grains, as well as the intestinal tract of animals, including man.

2 Paracolobactrum intermedium Bornan, Stuart and Wheeler. (Parafreundii, Stuart et al, Jour Bact., 45, 1943, 117, Borman, Stuart and Wheeler, Jour Bact., 48, 1944, 301.) From Lain intermedius, intermediate.

Characters as for Exchanging fraudit

Characters as for Escherichia freundirand Escherichia intermedium except for consistently delayed fermentation of lastase.

Source: From human gastroenteritis. Habitat Surface water, soil, grains, as well as the intestinal tract of animals, including man. 1. Paracolobactrum aerogenoides.

 Paracolobactrum intermedium e of carbon.

3. Paracolobactrum coliforme Borman Stuart and Wheeler. (Para-coli, Stuart et al., Jour. Bact., 48, 1941, 171; Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 361.) Latinized, resembing coli Characters as for Escherichia coli eveept for consistently delayed fermea-

Source: From human gastroenteritis Habitat: Surface water, soil, grains, as well as intestinal tract of animals, including man.

tation of lactose.

Note: The following also belong here: Bacterium paraeoli Stutrer and Wsorow. (Non-lactose-fermenting Bacterium coli, Gilbert and Lion, Semaine Méd., 13, 1893, 130; Stutzer and Wsorow, Cent. f. Bakt., II Abt., 71, 1927, 115) From intestines of healthy larvae of a moth (Euroa segetum).

Salmonella para-colon (Day) Hauduro' et al. (Bacillus para-colon Day; see Castellani, Cent. f. Bakt., I Abt., Dis-65, 1912, 264; also Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 939; Hauduroy et al., Diet. d. Bact. Fath., 1937, 461.)

\*Prepared by Dr. E. K. Borman, Bureau of Laboratories, State Department of

Health, Hartford, Connecticut, July, 1915

\*Appendix II. Tribe Escherichese: Gram-negative pertrichous to non-motile rods similar to organisms placed in Paracolohactrum Serratia and Salmanella havo recently been described as causing diseases of rentiles, birds and mammals. They may be grouped here although they have been placed in covered different general

1. Bacterium sauromali Conti and Crowley (Jour Bact . 36, 1938, 269) From a generic name of lizards Sauromalue

Short rods 02 to 05 by 10 to 20 microns, with rounded ends, occurring in groups. Motile with 4 to 6 peritrichous flagella Gram-negative

Gelatin Infundibuliform honefaction complete in 3 days at 37°C. Black sediment Medium browned

Agar slant, Growth shundant, spreading, convey, faint vellowish-green, glistening, smooth, translucent, butyrous Decided odor. Medium greened

Nutrient broth After 1 day at 37°C. moderate turbidity. Ring Decided odor Scanty flocculent sediment

Milk Alkaline and complete peptonization in ten days

Indole not formed

Potato Growth vellowish-green to olivo Blood medium Complete ainha

hemolysis in 48 hours Pentone medium Slight fluorescent

greenish-vellow pigmentation Nitrates produced from nitrates

Ammonia is produced

Acid and gas from elucose, sucrose, maltose, galactose, fructose, salicin and mannitol. Acid but not gas from glycerol. No acid from lactose, arabinose, vylose, dextrin, inulin, dulcitol or starch

Hydrogen sulfide produced Catalase positive

Methyl red test positive Pathogenic for animals

Temperature relations Ontimum

37°C Minimum 20°C Maximum 45°C Aerobic. Source From a tumor-like growth on

the chuckswalls (Sauromalus carrus) Habitat: Causes tumors in lizards

2. Serratia anolium Duran-Reynals and Clausen, (Jour. Bact. 38, 1937. 369 ) From a coneric name of liverde Analie

Rods 0.2 to 0.4 by 1.0 to 2.0 microns. occurring singly in pairs in clusters and nalisades Pleamarnhic other forms heing 4 to 5 microns in length curved occasionally club-like or 10 to 15 migrans long and surrounded by a capsular matarial, or occasionally small and coccus, like Motile (Duran-Reynals and Clausen) with 1 to 4 peritrichous florella (Broad) Non-seid-fast. Gram-negative.

Gelatin stab: Rapid growth faction infundabiliform. After 6 to 10 days a thick soft pellicle and blackish sediment is formed

Agar colonies: After 21 hours at 37°C. isolated colonies are low convey margin entire or slightly undulate Colonies translucent. butyrous. glistening. smooth, 10 to 25 mm in diameter. While some colonies retain their smooth character, others become larger, striated and wrinkled, showing opaque, radiated folds

rougher texture Penetrating acid smell produced. Agar slant After 21 hours at 37°C. abundant, confluent, raised, whitish, butyrous, glistening, with entire or

with irregularly crenated edges and a

undulate edges.

Broth Moderate growth with uniform turbidity A pellicle is formed which disintegrates forming a ring on the walls of the tube Sediment Faint fluorescent vellowish coloration

No visible gas in glucose broth (Breed) Peptone water After 6 to 10 days marked turbidity, medium darkened, blackish sediment formed

Litmus milk Coagulation and dices-Partial discoloration of the litmus

<sup>·</sup> Prepared by Prof Robert S Breed, New York State Experiment Station. Geneva, New York, June, 1946

Potato: Growth abundant, butyrous, glistening, raised, pinkish.

Indole not formed.

Blood is hemolyzed.

Locffler's serum: Abundant, glistening growth. Liquefaction.

No H₂S produced.

Ammonia is produced.

Although Duran-Reynals and Clausen report nitrites not produced from nitrates, a retest of their cultures by Breed has shown that nitrites are actively produced from nitrates.

Acid from glucose, fructose, sucrose, mannitol, maltose, galactose and salicin. Dextrin, lactose, inulin, dulcitol, xylose and arabinose slightly attacked or not at all.

Pigment production: Water-soluble pigment produced. Pink coloration best shown on glycerol potato. Reddish coloration best shown in peptone water with 2 per cent glucose, the yellow coloration in glucose broth and the black coloration in the sediment of liquefied gelatin and peptone water. Some non-pigmented strains.

Temperature relations: Grows well at 20°C. Growth more abundant at 37°C. Practically no growth at 10°C. Thermal death point 60°C for 20 minutes.

Aerobic.

Pathogenicity: Pathogenic for amphibnans, reptiles and to some extent fish. Lesions are produced in the iguand lizards (Anolis equesiris and Anolis carolinensis), the gakkonid lizards (Tarentola mauritanuca and Hemidactylus brookii), the gatter snake (Thamnophis bullers) and the brown snake (Storeria dekayii, the musk turtle (Sternothaerus sdoratus),

the toad (Bufo americanus), the free (Rana pipiens) and the cathis (Ameiuras melas). When the inoculated animal is kept at 37°C, the disease becomes general and usually is fatal. Non-pathogenic for warm-blooded animals (Clussa and Duran-Reynals, Amer. Jour. Path, 13, 1937, 441).

Source: From tumor-like lesions in Cubau lizards (Anolis equestris). Also isolated from iguanid lizards (Basiliscus vittatus) from Mexico by Clausen and Duran-Reynals (loc. cit.).

Habitat: The cause of a natural, nonfatal, contagious disease of lizards.

3. Salmonella sp. (Type Arizona). (Salmonella sp., Dar es salaam Type var. from Arizona, Caldwell and Ryerson,

zona culture, Edwards, Cherry and Bruner, Jour. Inf. Dis., 75, 1913, 236, Scimonella arizona Group, Edwards, Jour. Bact., 49, 1915, 513)

Ferments lactose and liquefies gelatin Antigenic structure: XXXIII: 24, 2p, 2m; -.

Source: Isolated by Caldwell and Ryerson (loc. cit.) from horned lizards, Gila monsters and chuckawallas. Also pathogenie for guinea pigs and rabbits. Found in snakes by Hinshaw and McNeill (Cornell Vet., 54, 1914, 218). Also reported by Edwards (loc. cit)

Habitat: Apparently widely distributed in lizards, snakes, and warmblooded animals.

from infants.

#### TRIBE II. ERWINEAE WINSLOW ET AL.

#### (Jour. Bact., 5, 1920, 209.)

Motile rods which normally require organic nitrogen compounds for growth. Produce acid with or without visible gas from a variety of sugars. In some species, the number of carbon compounds attacked is limited and lactose may not be fermented. May or may not liquefy gelatin. May or may not produce nitrites from nitrates Invade the tissues of living plants and produce dry necrosis, galls, with and soft rots. In the latter case, a protocetianse destroys the middle lamellar substance.

There is a single genus

#### Genus I. Erwinia Winslow et al.\*

(Jour. Bact, 2, 1917, 560.) Named for Erwin F. Smith, pioneer American plant pathologist.

Characters as for the tribe.

The type species is Erwinia amylovora (Burrill) Winslow et al.

### Key to the species of genus Erwinia.

 \*\*Pathogens which cause dry necrosis, galls or wilts in plants but not a soft rot (Erwinia sensu stricto).

- A. Gas not produced in sugar media.
  - 1. Gelatin liquefied.
    - a. Starch not hydrolyzed.
      - b Nitrites not produced from nitrates.
        - 1. Erwinia amulovora.
      - bb. Nitrites produced from nitrates.
      - 2. Erwinia milletiae.
    - as. Starch hydrolyzed.
      - b. Nitrites produced from nitrates.
    - san. Action on starch not reported.
      - b. Nitrites produced from nitrates.
      - 4. Erwinia cassarae.
    - 2. Gelatin not liquefied.
      - a. Starch not hydrolyzed.
        - b. Nitrites produced from nitrates.
        - 5. Erwinia salicis. bb Nitrites not produced from nitrates.
        - 6. Erwinia tracheiphila.

Completely revised by Prof. P. D. Chester, New York, N. Y., December, 1938;
 further revision by Prof. Walter H. Burkholder, Cornell University, Ithaca, New York, May, 1945.

<sup>\*\*</sup> The genus Lewina as defined here is heterogeneous in nature and is composed of at least two distinct groups. The first group constitutes Lewina proper and does not produce visible gas from sugars. Walder (fown State Coll. Jour. Sci., 19, 1915, 433) in a paper that appeared as this manuscript was ready for the press has suggested that the species in this first group be placed in a separate family Enginizera.

- II. †Pathogens which normally cause a soft rot in plants (largely belong in the genus Pectobacterium Waldee).
  - A. Gas produced in sugar media.
    - Gelatin liquefied.
      - a. Nitrites produced from nitrates.
        - b. Hydrogen sulfide produced.
          - 7. Erwinia hetivora
          - 8. Erwinia carneoieana.
        - bb. Hydrogen sulfide not produced
          - 9. Erwinia atroseptica. 10. Erwinia carotovora.
      - aa. Nitrites not produced from nitrates.
        - 11. Erwinia erivanensis.
        - 12. Erwinia flavida.
    - 2. Gelatin not liquefied.
      - a. Starch hydrolyzed
- 13. Erwinia dissolvens.
- aa. Starch not hydrolyzed.
- 14. Erwinia nimipressuralis.
- B. Gas not produced in sugar media.
  - 1. Gelatin liquefied.
    - a. Nitrites produced from nitrates
      - Starch hydrolyzed.
- 15. Erwinia ananas.
- 16. Erwinia cytolytica.
- bb. Starch not hydrolyzed.
  - c. Acid from lactose.
- 17. Ericinia aroideae.
- 18. Erwinia mangiferae. ec. No acid from lactose.
- 19. Erwinia citrimaculans.
- Gelatin not liquefied.
- 20. Erwinia rhapontici.
- 3 Very slow gelatin liquefaction. a. Nitrites not produced from nitrates.
  - - 21. Erwinia lathyri.
- C. Gas production not reported. 1. Gelatin liquefied.
  - a. Nitrites produced from nitrates.
    - - 22. Erwinia lilii.

<sup>†</sup> The second group of species usually causes soft rots, but includes a few not very typical species. Waldee (loc cit.) has proposed that the species that cause typical soft rot be placed in a new genus, Pectobacterium, with Pectobacterium carolocorum is the type species. The new genus is retained in the family Enterobacteriaceae. Wsl. dee would place the atypical species in other genera, Erwinia dissolvens for example being placed in the genus Acrobacter. As further comparative studies are needed before such changes can be made with confidence, the older arrangement is allowed to stand in this edition of the Manual.

1. Erwinia ampiorora (Burrill) Winslow et al. (Microsceus ampiororus Burrill, Illinois Indust. Univ, 11th Rept, 1822, 42; American Naturalist, 17, 1833, 301; Beachius ampiororus Trevisan, I generi e le specie delle Batteriacee, 1899, 19; Baterium ampiororus Chester, Del. Col. Agr. Exp. Sta., 9th Ann. Rept, 1877, 127; Baterium ampiororum Chester, Manual Determ Bact., 1901, 176; Winslow et al., Jour. Bact., 5, 1920, 2020.) From Latin, starch devouring

Description mainly from Ark, Phytonath 27, 1937, 1.

Rods 0 7 to 1.0 by 0 9 to 15 microns, occurring singly, in pairs and sometimes in short chains. Motile with peritrichous flagells. Gram-negative.

Gelatin colonies: Circular, whitish, amorphous, entire.

Gelatin stab: Slow crateriform liquefaction confined to the upper layer.

Agar colonies Circular, grayish-white, moist, glistening, irregular margins

Broth. Turbid, with a thin granular pellicle.

Potato: Growth white, moist, glistening. Medium not softened. No odor. No nigment.

Litmus milk: Congulated after 3 to 4 days to a pasty condition, with a separation of whey. At first acid, becoming alkaline. Litmus reduced. There is a gradual digestion of the casein

Blood serum Growth similar to that on agar No fiquefaction.

Dunham's solution. Rapid growth, but clouding not dense

Indole not produced.

Nitrites not produced from nitrates
Most of the strains gave a positive test
for ammonia in broth, a few showed only
a slight positive test.

Acetylmethylcarbinol produced. Growth in synthetic media with (NH<sub>4</sub>)<sub>1</sub>HPO<sub>4</sub> as a source of introgen and containing different carbohydrates.

Acid without ras from glucose, sucrose, arabinose, mannose, fructose, maltose, cellobiose, raffinose, salicin and amygdslin. Xylose, rhamnose, dulcitol and starch not fermented. Acid production from lactose and galactose variable. Utilizes salts of citric, malic, and hippuric scid. Action on salts of lactic and succente acids variable. Salts of benzoic, malece, malonic, oxalic, tartaric and valcric acid are not utilized.

Asparagine fermented with production of alkalı Glycine, valine, isoleucine, glutamic acid, cystine, tyrosine, tryptophane and urca not fermented.

Minimum temperature between 3° and 8°C. Maximum below 37°C.

Optimum pH 68. Minimum pH 4.0 to 4.4. Maximum pH 8.8

Source: From the blossoms, leaves and twice of the pear and apple.

Habitat Attacks a large number of species in several tribes of the family Rosaceae (Elliott, Manual Bact. Plant Pathogens, 1930, 19).

 Erwinia milletiae (Kawkami and Yoshida) Magrou. (Bacillus milletiae Kawkami and Yoshida, Bot. Mag , Tokyo, 34, 1920, 110, Magrou, in Hauduroy et al, Diet. d. Bact. Path., 1937, 213.)
 From Milletia, a genus named for A. J. Millett.

Rods: 0 4 to 0 6 by 0 9 to 2 5 microns Mottle with peritrichous flagella. Capsules. Gram-negative. Gelatin: Liquefaction begins after 8

days.

Agar colonies: Circular, flat, smooth, shiny, opaque, waxy yellow. Margins entire.

Broth: Turbid. Heavy precipitate.

Milk No congulation. Clears with

Conjac. No liquefaction.

Nitrites produced from nitrates Acid but no gas from galactose, fructose, lactose, maltose, sucrose and mannitol. No acid from glycerol.

Starch not hydrolyzed.

Growth in 02 per cent but not in 0.3 per cent of the following acids in sucrose peptone broth: Acetic, citric, oxalic and tartaric.

Acrobic.

Grows well at 32°C. Thermal death point, 53°C for 10 min.

Source. From galls on the Japanese wisteris in various localities in Japan.

Habitat: Causes galls on the Japanese

wisteria, Milletia floribunda.

3. Erwinia vitivora (Baccarini) du Plessis. (Bacillus vitirorus Baccarini, Bull. della Soc. Bot. Ital., 1891, 235; du Plessis, Dept. Agr. and Forestry Union of S. Africa, Science Bul. 214, 1910, 58) From Latin, devouring the vine

NOTE, Macchiati (Bol. della Soc. Bot. 1897, 156) uses the name Bacillus baccarinit for Bacillus ritirorus. The description Macchiatt gives is not of Erwinia vitivora but is evidently that of a saprophyte occurring with the patho-He conducted no inoculation experiments. Migula (System der Bakterien, 2, 1900, 778) gives Bacıllus ritivorus Bace. (Malpighia, 6, 1892, 229) which is an incorrect citation and Bacillus baccarınıı Macch 1897, as synonyms of Bacillus aummis Comes 1884 impossible to determine what this latter species is. Du Plessis (loc. cit ) does not believe Bacillus aummis is the same as Ericinia eitirora.

Rods: 0.74 (0.44 to 1.10) by 1.46 (0.95 to 2.19) microns. Cells sometimes dumbbell-shaped Motile with peritrichous flagella. Gram-negative. Capsules present.

Gelatin: Liquefaction

Agar colonies First punctiform, irregularly circular or lenticular, ultimately circular, raised to pulvinate, glistening, spreading, light to orange-yellow Agar becomes brown.

Broth: Turbid in 24 hrs. Whitish to

lemon yellow pellicle.

Milk: Litmus reduced. Thread-like to spongy curd formed. Yellow whey about curd: Yellow growth on top of plain milk. Medium acid. Uschinsky's solution: Slowly becomes turbid. Pellicle. Sediment whitish-yellow.

Nitrites produced from nitrates.

Hydrogen sulfide produced.

Acid produced from glucose, fructose, xylose, lactose, sucrose, mannitol and salicin. No acid from raffinose or inulia Starch hydrolyzed.

Facultative anaerobe.

Temperature relations: Optimum 25°C Maximum 35° to 40°C. Minimum 5° to 10°C.

Optimum pH 6.0. Minimum 4.2. Source: Du Plessis used 5 isolates from

various localities in South Africa
Habitat: Causes a disease of grape vines
in South Africa. Italy and France.

 Erwinia cassavae (Handsford) comb nov. (Bacterium cassavae Handsford, Ann. Rept. Dept. Agric. Ugands for 1937, II, 1938, 48.) From cassava, the host plant.

Rods: Motile with a few peritrichous flagella No capsules. Gram-negative Gelatin is slowly liquefied.

Agar colonies: Smooth, lens shaped, edges entire, translucent and of uniform

structure. Yellow.

Broth: Turbid with a ring. A yellow

precipitate in old cultures.

Milk becomes alkaline: Not cleared

Nitrates are rapidly reduced to ni-

Methyl red test negative. Acetyl-

methylcarbinol produced (Dowson, Cent f. Bakt., II Abt , 100, 1939, 183).

Acid but no gas from glucose, sucrose, maltose and glycerol, but not from luc tose.

Facultative anaerobe.

Source: From necrotic lesions on cassaya leaves in Uganda

Habitat: Pathogenic on cassava, Manihot sp.

5. Erwinia salicis (Day) Chester. (Bacterium salicis Day, Oxford For. Mem., 3, 1924, 14; Phytomonas saluis

Magrou, in Hauduroy et al, Diet. d. Bact. Path., 1937, 408; Chester, in Bergoy et al., Manual, 5th ed, 1939, 406.) From Latin salix, willow; M. L. generie name Salir

Description from Dowson, Ann. Appl Biol., 24, 1937, 542.

Rods: 0 5 to 0 7 by 0 8 to 2.2 microns, occurring singly or in pairs, rarely in chains, with rounded ends. Motile with 5 to 7 long peritrichous flagella. Grammentius.

Gelatin stab: Beaded growth N

Infusion agar: Colonies appear slowly, circular, with slightly uneven margins, nale brown by transmitted light, nale

gray by reflected.

Infusion agar slants: Growth thin,
nearly transparent.

Broth: Moderate, uniform turbidity.

No pellicle.
Litmus milk: No change.

Potato: Bright yellow, later fading to pale brown, spreading, abundant, glistening, slimy growth.

Indole not formed.

Nitrates produced from nitrates (Dowson)

Hydrogen sulfide not produced. Ammonia not produced

Acetylmethylcarbinol produced Methyl red test negative (Dowson, Cent f Bakt , II Abt., 100, 1939, 183).

Acid, but no gas, from glucose, galactose, mannose, xylose, maltose, sucrose, raffinose, glycerol, mannitol and sahein No growth in arabinose, fructose, rhamnose, inulin or dettrin

No growth in Cohn's solution.

Starch not hydrolyzed. Temperature relations, Optimum 29°

to 30°C Minimum 5° to 10°C Maximum 33° to 37°C. Thermal death point 50° to 52°C.

Aerobic, facultative anaerobic.

Source. From the cricket-bat willow

(Salix carrules) and from the white willow (Salix alba). Habitat. Causes a water-mark disease of willow in England Erwinia trachelphilu (Erw. Smith)
 Holland. (Bacillus trachelphilus Erw.
 Smith, Cent f. Bakt., II Abt., I, 1835,
 Baterium trachelphilus Chester,
 Ann. Rept. Del. Col. Agr. Exp. Sta.,
 1897, 72; Smith, see Bacteria in Relation to Plant Diseases,
 2, 1911, 285;
 Holland, Jour. Bact. p. 1920, 215.
 From Greek, trachea-loving, i.e., live in throwseels bundles.

Reds: 0 5 to 0.7 by 1.2 to 2.5 microns, with rounded ends, occurring singly and in pairs, more rarely in fours. Motile with peritrichous flagella. Capsulated.

Gelatin colonies Small, circular, grayish-white, smooth, glistening. Show internal string by transmitted light.

Gelatin stab: Surface growth thin, spreading, grayish-white. Slight filiform growth in depth No liquefaction.

Agar colonies. Small, circular, grayishwhite, smooth, glistening

Agar slant: Growth grav. smooth.

filiform, moist, glistening Broth: Slight turbidity. No ring or

pellicle.

Potato: Growth white or color of substratum, smooth, moist, glistening. No action on the starch. Does not soften

the middle lamella of potato cells.

Litmus milk. Not congulated. Reaction unchanged Litmus not reduced

Not peptonized. Egg albumen: Not directed.

Blood serum: No liquefaction Cohn's solution: No growth Uschinsky's solution: Weak growth

Fermi's solution: Weak growth. Indole not formed in Dunham's solution.

Nitrites not produced from nitrates.

Ammonia production moderate.

Cannot utilize asparagine, ammonium lactate or tartarate as sources of nitrocen.

Acid without grs from glucose, sucrose and fructose; growth in closed arm Acid from glycerol No growth in closed arm with lactose, maltose, dextrin, glycerol or mannitol. No acid from lactose Starch not hydrolyzed.

Hydrogen sulfide production feeble. Growth in broth with 1.0 per cent NaCl retarded: inhibited with 2.0 per cent.

Very sensitive to acid (phenolphthalein):

Temperature relations: Optimum 25° to 30°C. Minimum about 8°C. Maximum 34° to 35°C. Thermal death point 43°C for one hour.

Aerobe and facultative anaerobe. Source: From various curcurbits.

Habitat: Causes the wilt of cucumber, also affects cantaloupes, muskmelons, numpkins and squashes.

6a. Bacillus tracheiphilus var. cucumis E. F. Smith. (An Introduction to Bact. Dis. of Plants, 1920, 135.) Smith states that squash is immune to this variety of Ericinia tracheinhila

7 Erwinia betivora (Takimoto) Magrou. (Bacillus betivorus Takimoto, Ann. Phyt. Soc. Japan, 2, 1931, 356; Magrou. in Haudurov et al., Dict. d. Bact. Path .. Paris, 1937, 200). From Latin. devouring the beet.

Rod: Short rods, sometimes filaments. Motile with 2 to 6 peritrichous flagella. Gram-negative.

Gelatin: Liquefaction.

Agar colonies · Circular or amoeboid, homogenous, thin, edges smooth and entire

Broth · Turbid with pellicle.

Milk Acid; coagulated.

Nitrites produced from nitrates Indole produced.

Hydrogen sulfide produced. Gas from glucose and sucrose.

Facultative anaerobic.

Optimum temperature 35°C, Minimum 12°C. Maximum 45°C. Thermal death point 50°C for 10 min

Source: From rot of sugar beets in Korca.

Habitat: Pathogenic on roots of beets. Artificial inoculation of carrots, radishes, notato tubers and tomato fruits gave positive results.

8. Erwinia carnegicana Lightle, Standring and Brown. (Phytopath., \$2, 1942. 310.) From the genus Carnegica.

Rods: 1.12 to 1.79 by 1.50 to 290 microns. Motile with peritrichous flagella. Capsules. Gram-positive (Lightle et al.). Gram-negative: old cultures show Gram-positive granules in cells (Burkholder).

Gelatin: Slow liquefaction.

Agar colonies: Round, slightly raised, smooth, gray-white, wet-shining, marcins entire.

Broth: Abundant growth.

Uschinsky's solution: Turbid, slight ring and sediment.

Milk: Litmus pink to reduced, No curdling.

Nitrites are produced from nitrates. Hydrogen sulfide is formed (Burkholder).

Acid and gas from glucose, galactose, fructose, maltose, sucrose, raffinose, mannitol and salicin. Acid and gas from lactose and xylose and alkali from sodium tartrate (Burkholder).

Starch not hydrolyzed (Burkholder).

No odor.

Aerobic. Thermal death point 59°C.

Source : From rotting tissue of the giant cactus (Carneniea gigantia).

Habitat: Pathogenic on the giant cactus, but not on carrots

9. Erwinia atroseptica (van Hall) (Bacillus atrosepticus van Jennison. Hall, Inaug. Diss., Amsterdam, 1902, 134; Jennison, Ann Missouri Bot. Gard, 10, 1923, 43.) From Latin ater, black

and septicus, putrefying. Synonyms: Morse (Jour. Agr. Res , 8, 1917, 79) lists the following synonyms: Bacillus solanisaprus Harrison, Cent. f. Bakt., II Abt , 17, 1906, 3t (Erwinta solanisapra Holland, Jour. Bact., 5, 1920, 222) and Bacillus melanogenes Pethybridge and Murphy, Roy. Irish Acad. Proc., 29, B, No. 1, 1911, 31.

Paine (Jour. Agr. Sci., 8, pt. 4, 1917,

492) agrees and points out that Becillus phytophthorus Appel is very similar to Bacillus melanogenes Pethybridge and

Murphy.

Jennison (Ann Missouri Bot, Gard., 10, 1923, 1) concurs and adds Bacillus phytophthorus Appel, Ber. d. Deut Bot. Gesell., 20, 1902, 128 (nomen nudum) and K. Biol. Anst. f. Land. u. Forst Arb., 3. 1903, 361 (This last reference contains Appel's description which is antedated by van Hall's description of the black leg pathogen.)

Stapp (Arb. d Biol. Reichs f Landu Forst., 16, 1928, 702) besides the above soccies adds Bacillus carolovorus Jones but uses the name Bacillus phytophthorus and states that the species contains 5

serological grouns.

Description from Jennison (loc. cit.). Rods: 06 by 15 microns. Motile with a few peritrichous flagella. No capsules Gram-negative.

Gelatin honefied

Agur colonies: Small, round to somewhat irregular and whitish, Surface smooth with a clistening luster. Ring

Broth: Turbid after a few days and sometimes a light pellicle

Ammonia production feeble to moderate (Jennison). Ammonia production absent (Morse, loc cit ).

Milk congulated and acid. A slow pentonization. Litmus reduced

Indole not formed.

Hydrogen sulfide not produced Nitrites are produced from nitrates

Acid and gas from glucose, galactose, sucrose, lactose, maltose and mannitol No acid and gas from dextrin and glycerol. Volume of gas is small.

Starch not hydrolyzed.

Cohn's solution: No growth. Uschinsky's solution; Good growth. Facultative anerobe (Morse, loc cit )

Optimum temperature 26°C. Maximum 33°C. Minimum below 5°C (Morse).

Slight growth with 3 per cent salt. None with 4 per cent salt.

Source: From stems of potatoes affected with black-leg.

Habitat: Causes a black rot on stem and tuber of potatoes and other vecetables.

Nore: Smith (Science, 31, 1910, 748) regarded Erwinia solanisapra and Eruinia phytophthora as very closely related. Brooks, Nain and Rhodes (Jour. Path. and Bact., £8, 1925, 203) held that Erwinia phytophthora, Erwinia solanisapra and Erminia carolovora are distinet serologically, although identical in cultural characteristics. (Ann. Appl. Biol., 13, 1926, 12) claimed from serological tests that Erunnia phytophthora and Erwinia solanisapra are different yet closely related organisms. Lacey (Ann. April. Biol., 13, 1926. 1) from cultural and serological tests considered Erwinia phytophthora, Erwinia solanisapra and Erwinia carotororg distinct species. Stapp (Arb. a. d. Biol. Reichanstalt f. Landw. u. Forstwirtsch., 16, 1928, 643) from serological tests places Erwinia phytophthora in one serological group and Erwinia carologora in another. Leach (Phytopath., 20. 1930, 743) found that Erurnia phytophthere and Erwinia carolotora nere indistinguishable in cultural and physiolocical characteristics, the most consistent difference being the inky black coloration of the tissues infected with the former.

Stapp (in Soraver, Handb d Pflanzenk., 5 Aufl., 2, 1928, 229) states that it is generally believed that the disease caused by Bacillus solunincola Delacroix (Compt. rend. Acad. Sci., Paris, 133, 1901, 417 and 1030) is the same as stem rot of potato (blackleg).

10. Erwinia carotovora (Jones) Holland. (Bacillus carotororus Jones, Cent. f. Bakt., II Abt., 7, 1901, 12; Holland, Jour. Bact , 5, 1920, 222; Bacterium carotororum Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 446; Pectobacterium carotovorum Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 469.) From Latin, carrot destroying.

Synonyms · Leach (Minnesota Agr. Exp. Sta. Tech Bull, 76, 1931, 18) lists

the following as synonyms:

Bacillus atrosepticus van Hall. (Van Hall, Inaug. Diss, Univ Amsterdam, 1902, 134; Erwinia atroscoptica Jennison. Ann. Missouri Bot. Gard., 10, 1923, 43.)

Bacillus phytophthorus Appel. d. deut Bot. Ges., 20, 1902, 128; Erwinia phytophthora Holland, Jour. Bact., 5, 1920, 222; Bacterium phytophthorum Burgwitz, Phytopath, Bacteria, Leningrad, 1935, 141; Pectobacterium phytophthorum Waldee, Iowa State Coll Jour. Sci. 19, 1945, 471)

Bacillus solanisaprus Harrison. (Harrison, Cent f. Bakt, II Abt, 17, 1907, 34; Erwinia solanisapra Holland, Jour. Bact., 5, 1920, 222.)

Bacillus melanogenes Pethybridge and Murphy. (Roy Irish Acad , 29, B, No. 1. 1911. 31 )

Bacillus oleraceae Harrison (Harrison, Science, 16, 1902, 152, Erwinia oleraceae Holland, Jour Bact , 5, 1920, 222.)

Bacillus omnivorus van Hall. (Inaug. Diss , Univ. Amsterdam, 1902, 176 )

Bacillus apnorus Wormald Sci., 6, 1914, 203.)

Elrod (Bot Gaz, 103, 1941, 270) holds that Erwinia aroideae is a synonym of Erwinia carotovora

as possible synonyms of Erwinia caro-ison.

Bacillus cepivorus Delacroix. croix, Ann. Inst Nat Agron, Ser 0, 1923, 43.) From Latin ater, black 5, 1905, 368, Bacterium cepivorum Stapd septicus, putrefying. in Sorauer, Handb. d. Pflanzenkrantynonyms: Morse (Jour. Agr. Res. & heiten, 5 Aufl., 2, 1928, 49; Aplanobacte., 79) lists the following synonyms: cepivorus Elliott, Man Bact Plant Path ,llus solanisaprus Harrison, Cent. f. 1930, 4; Phylomonas cepurora Magrou. II Abt., 17, 1906, 31 (Erwinia in Hauduroy et al., Diet. d. Bact. Path., sapra Holland, Jour. Bact., 6, 1929, 1937, 344.) Causes a rot of onion bulbs. and Bacullus melanogenes Pethy-

Cent f. Bakt., II Abt., 31, 1911, 85; 29, B, No. 1, 1911, 31. Erwinia cypripedii Bergey et al., Manual, \((Jour. Agr. Sci., 8, pt. 4, 1917, 1st ed., 1923, 171.)

Bacillus dahliae Her, and Bokun (Hori and Bokura, Imp. Agr. Expt. Sta. Nishigahara, 38, 1911, 69; Erwinia dahlias Magrou, in Hauduroy et al., Diet. d Baet. Path., 1937, 205.)

Pseudomonas destructans Potter (Potter, Proc. Univ. Durham Philos. Soc., 1899, 165 and Proc. Roy. Soc., 67, 1900, 449; Bacterium destructans Nakata, Nakajima and Takimoto, Tech. Rept Korea Ind. Farm, 1922; Phytomonas destructans Bergey et al., Manual, 3rd ed., 1930, 264.) See Paine (Ann. Appl. Biol., 5, 1918, 64) for a discussion of this species.

Bacillus hyacinthi septicus Heinz. (Heinz, Cent. f: Bakt., 5, 1889, 539; Bacillus hyacinthi-septicus Lehmann and Neumann, Bakt. Diag., 2 Aufl., 2, 1899, 449: Bacterium hyacinthi septicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 127; Bacillus hyacinthi Migula, Syst. d. Bakt., 2, 1900, 874; not Bacillus hyacinthi Trevisan, I generi e le specie delle Batteriacee, 1899, 19, Eruinia hyacinthi septica Magrou, in Hauduroy et al , Dict. d. Bact. Path, 1937, 208)

Rods. Usually 0.7 to 22" microns, o point 59°C. rather on rotting tissue of the giant with rnegiea gigantia). sul 5: Pathogenic on the giant cac-

The following also have been considered drwinia atroseptica (van Hall) (Bacillus atrosepticus van il, Inaug. Diss., Amsterdam, 1902,

(Dod; Jennison, Ann. Missouri Bot. Gard,

on carrots

Bacillus cypripedu Hori. (Hori, and Murphy, Roy. Irish Acad

Potato: Growth thick, creamy-white; medium softened.

Dunham's solution Feeble persistent

Blood serum : Growth much as on agar.

Not liquefied.
Uschinsky's solution Strong turbidity.

Indole production none.

Nitrites produced from nitrates

Diastase negative.

No H<sub>4</sub>S produced or only a trace

Methyl red positive, Voges-Proskauer negative (Dowson, Cent f Bakt, II Abt., 190, 1939, 183).

Acid and gas from glucose, lactose, sucrose, fructose, raffinose, mannitol, arabinose, vylose, salicin and rhamoose Acid without gas from glycerol and ethyl alcohol. Butyl alcohol, inulin and starch not fermented.

Facultative anerobe

Temperature relations: Optimum 25° to 30°C. Minimum 4°C. Maximum 38° to 39°C. Thermal death point 41° to 51°C.

Pathogenesis. Causes a rapid soft rot of roots, rhizomes, fruits and the fleshy stems of a variety of plants

stems of a variety of plants Source, From rotted carrots.

Habitat: Causes a soft rot in carrot, cabbage, celery, cucumber, egg-plant, iris, muskmelon, hyacinth, omon, parsnip, pepper, potato, radish, tomato, turnip, and other plants.

 Erwinia erivanensis (Kalontarian) Becsey et al. (Bacterium erizaneaus Kalantarian, Cent I. Bakt, H. Abt, 65, 1925, 298, Bacillus eritaneasis Stapp, in Sorauer, Handb d. Pfanzenkr, 5 Vull. 2, 1928, 202; Bergey et al., Manual, 3rd ed., 1930, 293) Derived from Livian, a city in Armenia
 Whether this organism is to be con-

adered a chromogenic strain or a distinct pecies is impossible to determine, thereline it occupies its present position. Slight ely. It cannot be separated

Slight ely. It cannot be reparated None with one carolorers on the basis of chromogenesis since the latter occasionally shows a tendency to the formation of a faint vellowish nument

Rods · 0 5 to 0 7 by 1.25 to 2 5 microns.

Motile with peritrichous flagella. Gram-

neostite

Gelatin colonies After 3 days at 20°C, erreular, 1 to 15 mm in diameter, yellowish-white, convex, entire Microscopically gray with opaque borders and darker patches

Gelatin stab Surface growth somewhat umbonate In 10 to 12 days a slow liquefaction. Intense yellow growth.

Agar colonies Grayish-white, fatty lustre, turning yellow after several days Agar slant. Growth grayish-white, fatty lustre, becoming yellow

Broth. Strong more or less flocculent turbidity No surface growth. Little

sediment.
Potato. Growth somewhat raised, be-

coming yellowish

Milk Congulated in 14 days, becoming alkaline, slowly clearing.

Indole is formed.

Nitrites not produced from nitrates Acid and gas from glucose, sucrose and mannitol. No gas from lactose and glucorol

Optimum temperature 20°C.

Source From cotton plants.

Habitat. Causes a root-rot of cotton
(Gossprium ap)

12 Erwinia flavida (l'aucett) Magrou (Bacillus flavidus Faucett, Rev Indust. y Agneo de Tucuman, 14, 1922, 5; Rev. App. Mycology, 2, 1923, 333, mot Bacillus flaridus Morse, Jour. Inf. Dies, 11, 1912, 251, Magrou, in Hauduroy et al., Diet. d Bact Path., 1937, 207.) From Latin flaus, y climate, y characteristics.

Morphology Motile with peritrichous flagella Gram-negative.

Gelatin, Yellow growth, Liquefuc-

Milk. Congulated Potato Yellow growth Indole is formed.

Nitrites not produced from nitrates. Acid and gas from glucose, lactose and sucrose.

Diastase not formed.

Source: From sugar cane.

Habitat: Causes a soft rot of sugar cane (Saccharum officinarum).

NOTE: If this decay is due to a simple organism as stated above, it is probable that it should be considered merely a chromogenic strain of Erwinia carotovora.

13. Erwinia dissolvens (Rosen) comb. (Pseudomonas dissolvens Rosen, Phytopath., 12, 1922, 497; Phytomonas dissolvens Rosen, Phytopath., 16, 1926, 264; Bacterium dissolvens Rosen, ibid.; Aplanobacter dissolvens Rosen, ibid.; Aerobacter dissolvens Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 473.) From Latin, dissolving.

Rods: 0.5 to 0.9 by 0.7 to 1.2 microns. Pairs, rarely in chains, Capsules present. First described as motile with a single flagellum, later as non-motile. Gram-negative.

Gelatin. Not liquefied.

Agar colonies: Round, margins entire. white, opaque, glistening, butyrous, emitting a strong odor of decaying vegetables.

Broth Turbid with heavy surface growth consisting of ring, and floccules or compact slimy masses and streamers. Abundant sediment.

Uschinsky's solution: Good growth, but not viscid.

Litmus milk: Acid, coagulated.

Indole produced.

Nitutes produced from nitrates. Hydriogen sulfide not produced-Acid hand gas from glucose, galactose,

mannitoril, sucrose, maltose, lactose and giycerol, Ph.

Starch by dydrolyzed.

Optimum Cd temperature 30°C.

Good growpyth in 3 per cent salt. Retarded at 4 kt., her cent.

Source: Empedem rotting corn stalks. Rabitat. P. 171.) thogenic in corn plants.

14. Erwinia nimipressuralis Carter. (Illinois Nat. Hist. Survey Bull. 23. 1945. 423.) From Latin nimis, too much and pressuralis, pertaining to pressure.

Rods: Mostly 0.34 to 0.68 by 0.68 to 1.35 microns. Motile with as many as 6 peritrichous flagella. Capsules not observed. Gram-negative.

Gelatin: Not liquefied.

Potato glucose agar: Colonies circular. smooth, whitish-cream, entire, flat to slightly raised and usually opaque. Gas produced when medium is stabled.

Broth: Abundant with thin pollicle or flocculent surface growth. Sediment scant and viscid. Gas produced in nutrient broth plus glucose was 47 per cent CO: and 2.4 per cent hydrogen CO; varied with age of culture, more being produced in young cultures.

Milk: Acid, congulated. Litmus and bromocresol purple are reduced. Not pentonized.

Nitrates produced from nitrates.

Hydrogen sulfide produced.

Indole not produced.

Acid and gas produced from arabinose, rhamnose, xylose, glucose, fructose, galactose, mannose, lactose, maltose, trehalose, melibiose, cellobiose, mannitol, sorbitol and salicin; no acid or gas from inulin, dextrin or filterpaper; variable results from sucrose, raffinese, melezitose, dulcitol, glycerol and elm sawdust. Pectin is not fermented.

Starch not hydrolyzed.

Methyl red test positive. Acetylmethylcarbinol produced.

Facultative anaerobe.

Optimum temperature 21° to 30°C Maximum 37°C. Minimum 5°C or lower

Thermal death point 45° to 55°C. Optimum pH for growth 68 to 75

Maximum 100+. Minimum 40.

Source : Five cultures from 5 different trees affected with wet wood.

Habitat: Pathogenic in trunk wood of elms, Ulmus americana, U. pumila, U fulva and U. procera.

15. Fredinia ananas Sorrano (Philipnine Jour Sci 36 1928 271 - Racillus ananas Serrano, thid : Bacterium ananas Burgaitz, Phytomathogenic Bacteria. Lanungrad 1935 41 ) Named for the genus Ananas

Note: Not to be confused with Pseudomonas (Phytomonas) ananas Serrapo. Philippine Jour. Sci., \$6, 1928, 271.

Short rods: 06 by 09 micron, with rounded ands accurring singly in pairs and in short chains. Encapsulated. Motile with peritrichous florella Gramnegative

Gelatin stab. Stratiform liquefaction. with a deep chrome-vellow sediment.

Potato glucose agar: After 24 hours, circular, 3 mm in diameter convex. dense, homogeneous, entire moist, strawvellow, mottled, becoming primuline vellow. Plates have a molasses odor. Show two types of colonies, much and smooth Rough colonies have cremate margins.

Potato glucose agar slant. Growth straw-vellow, raised, becoming primit-

line vellow, moist, glistening Broth: Turbid, with a straw-colored

pellicle and ring Glucose broth: Growth sulfur vellow. Litmus milk Congulated, faintly

acid, becoming alkaline. Potato. Copious growth, moist, glistening, spreading, becoming primuline vellow

Indole not formed

Blood serum: Moderate growth. slightly raised, mustard vellow to primuline yellow. No liquefaction after 3 months

Cohn's solution . No growth.

Phenol negative. Diastase produced.

Nitrites produced from nitrates.

Slight amount of ammonia produced Slight amount of H.S produced.

Small amount of alcohol and aldehyde produced.

No cas from carbohydrates, Acid from glucose, lactose, sucrose, mannitol,

raffinose glycerol salicin devtrin maltose fructose and mannose. No acid from arabinose, xylose, amyodalın, rhamnose, inositol, inulia, dulcitol, adoutol, esparanine or sterch

Source: From the pineapple (Anguas sativus) and sucar-cane (Saccharum officinarum)

Habitat Couses a brown rot of the fruitlets of pipeapple.

16 Erwinia extelettes Chester (Phytonath \$8,1938 431.) From Latin, cell

dissolving. Rods · 06 to 07 by 25 to 35 microns.

Singly or in pairs Gram-negative, Motile with peritrichous flarella.

Gelatin: Slow liquefaction

Amr colonies: 2 to 3 mm in diameter. round, convey, moist, glistening, gravishwhite, watery, translucent. brownish-vellow by transmitted light. Broth . Turbid.

Milk. Coagulated in 5 to 7 days. Slightly acid. Not digested

Nitrates produced from nitrates.

Indole not formed. Hydrogen sulfide not formed Acetylmethylcarbinol. A slight reac-

tron Acid without gas from glucose, lactore,

sucrose, raffinose, mannitol, salicin and isodulettel. No acid from fructose, arabmose, xylose, glycerol and inulin.

Starch hydrolyzed.

Peetin dissolved.

Asparagine, peptone, and ammonia used as nitrogen sources in synthetic medium plus glucose. Potassium nitrate not used

Ontimum temperature 25° to 30°C. Growth at 37°C Slow growth at 20°C and no growth at 8° to 10°C. Good growth at pH 68 to 7.3. Feeble

growth at 50 No growth at 4.4.

Acrobic and facultative anacrobic. Source · Several isolates from diseased

dahlins in New York Botanical Garden. Habitat: Causes a rot of the tuber and stems of dahlias

17. Erwinia aroideae (Townsend) Holland. (Bacillus aroideae Townsend, U. S. Dept. Agr., Bur. Plant Ind. Bull. 60, 1904, 40; Holland, Jour. Bact., 5, 1920, 222; Bacterum aroideae Stapp, in Sorauer, Handb. d. Pflanzenkr., 5 Aufl., 2, 1928, 41; Pectobacterium aroideae Waldee, Jowa State Coll. Jour. Sci., 19, 1945, 172.) From Greek, pertaining to the family Araceae.

Probable synonyms: Erwinia croci Alizusawa) Magrou. (Bacillus croci Mizusawa, Kanag. Agr. Exp Sta Bull. 51, 1921, 1; Ann Phytopath. Soc. Japan, 1, 1923, 1; Magrou, in Hauduroy et al., Dict. d Bact. Path., 1937, 201.) Attacks Crocus satigus. also onion.

Erwina melonis (Giddings) Holland. (Bacillus melonis Giddings, Vermont Agr. Exp Sta Bull. 148, 1910, 413; Holland, Jour. Bact., 5, 1920, 222; Pectobacterium melonis Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 473.) E. F. Smith (An Introduction to Bact. Dis of Plants, 1920, 240) considered Eruinia melonis and Erwinia aroideae identical. Causes a soft rot of muskmelon

Erunna papaceris (Ayyar) Magrou. (Bacillus papaceris Ayyar, Mem. Dept. Agr. India, Bact. Ser 2, 1927, 29, Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 214) The cause of a soft rot of the garden poppy.

Rods 0.5 by 2 to 3 microns, with rounded ends, occurring singly, in pairs and in fours, also in chains under certain conditions Motile with peritrichous flagella. No capsules. Gram-negative. Gelatin stab. Narrow infundibuliform

liquefaction.

Agar colonies Circular to amoeboid,

white, glistening Borders sharp Granular structure

Agar slant Growth white to grayishwhite, moist, glistening. Medium not discolored

Broth · Turbid.

Potato: Growth whitish, with tinge of vellow. Medium graved

Litmus milk: Coagulated, acid, with

separation of whey, not peptonized. Litmus reduced.

Indole not formed.

Nitrites produced from nitrates.

Acetylmethylcarbinol produced Methyl red negative (Dowson, Cent. f. Bakt., II Abt., 100, 1939, 183).

Acid without gas from glucose, lactose, sucrose, maltose, mannitol, glycerol, fructose, raffinose, arabinose and xylose Growth in closed arm.

Diastase slight.

Hydrogen sulfide produced.

Uschinsky's solution: Good growth No growth in nitrogen. Growth feeble in H<sub>2</sub> and CO<sub>2</sub>.

Temperature relations: Optimum 35°C. Minimum 6°C. Maximum 41°C. Thermal death point 50°C for 10 minutes.

Facultative anaerobe.

Differential characters: See Erninia carotocora.

Massey (Phytopath, 14, 1924, 460) considered Erwinia aroideas and Erwinia carotocora distinct species, though closely related. Link and Taliaferro (Bot. Gazette, 85, 1928, 1938) found them distinct serologically. Dosson (Ann. Appl. Biol., 28, 1941, 192) differentiated them on their action on maltose and xylose.

Source: From rotted calla lily.

Habitat: Causes a soft rot of calla. Affects raw potato, egg-plant, cauliflower, radish, cucumber, cabbage, parsnip, turnip, salsify, tomato (ripe and green).

18 Erwinia mangiferae (Doidge) Bergey et al. (Bacillus mangiferae Doidge, Ann Appl. Biol., 2, 1915, 1; Bergey et al. Manual, 1st ed., 1923, 173.) Named for the genus, Mangifera.

Rods: 06 by 1.5 microns, occurring singly and in chains, with rounded ends Encapsulated. Motile with peritrichous flagella Gram-negative.

Gelatin stab: Medium liquefied in 10

to 17 days. Growth yellow.

Agar colonies: Glistening, yellowish,
undulate borders.

Agar slant: Growth yellow, glistening. Broth: Turbid, with yellow ring.

Litmus milk: Slow coagulation at Casein slowly 37°C. Slight acidity.

dissolved. Litmus reduced. Potato: Growth spreading, glistening,

yellowish. Medium not discolored. Indole formed in peptone solution Phenol negative.

Nitrites produced from nitrates

No H2S produced. No ammonia in broth.

Feeble acid production without gas from glucose, lactose, sucrose, fructose

and glycerol. No growth in closed arm with lactose and glycerol, more or less growth in closed arm with glucose, sucrose, fructose, maltose, raffinose and mannitol.

Diastase not formed.

Produces an enzyme capable of dissolving the middle lamella but without action on cellulose.

Cohn's solution: Slight turbidity.

Uschinsky's solution: No growth Fermis' solution with starch jelly No growth

Pigment insoluble in water, alcohol, ether, chloroform or dilute acids Temperature relations Optimum 30°C

Minimum 5° to 6°C. Maximum 45°C Thermal death point 60°C.

Source: From the mango in Africa Habitat · Causes a disease of the mango (Mangifera indica).

19 Erwinia citrimaculans (Doidge) Magrou (Bacillus estramaculans Doidge, Ann. Appl. Biol., 3, 1917, 53, Bacterium citrimaculans Burgwitz, Phytopath Bacteria, Leningrad, 1935, 151; Magrou, in Hauduroy et al , Diet. d. Bact Path , 1937, 203.) From the genus Citrus and latin maculans, spotting,

Rods: 0 45 to 0 7 by 0 5 to 3 2 microns Mottle with peritrichous flagella Conspicuous capsule present Gram-po-itive. Dowson thinks this species Gramnegative (Cent f Bakt, II Abt, 100, 1939, 184)

Gelatin: Liquefied.

Agar colonies: Subcircular, vellow, with dense grumose centers

Broth: Turbid, with pellicle and sediment.

Milk: Coagulated, with precipitation of casein and extrusion of whey. Not peptonized Litmus gradually reduced. Blood serum : Not liquefied.

Indole is formed.

Nitrites produced from nitrates with evolution of gas.

Ammonia produced in broth.

Acid without visible gas from glucose, sucrose, fructose, galactose, maltose and mannitol. No acid from lactose, glycerol, dextrin or starch

Diastase not produced.

Cohn's solution No growth. Usehinsky's solution: Growth present.

No growth in broth over chloroform. Methylene blue and neutral red reduced.

Pigment insoluble in water, alcohol, ether, chloroform, carbon bisulfide, dilute acid or alkalis

A turbid growth is produced in 10 per cent salt

Temperature relations: Optimum 35°C. Maximum 43°C. Thermal death point 62°C for 10 minutes.

Facultative anaerobe.

Source From diseased lemons and oranges

Habitat Causes a spot disease of In nature attacks lemons, oranges, haartjes and has also been successfully moculated into limes, shaddock, grapefruit and citron Seville oranges are resistant

20 Erwinia rhapontici (Millard) comb. nor (Phytomonas rhapontica Millard. Univ Leeds and Yorkshire Council for Agr. Ed. Bul. 131, 1921, 111: Bacterium rhaponticum Millard, ibid ; Aplanobacter rhaponticum Elliott, Man Bact. Plant Path , 1930, 12 ) From Greek Rha pontic, rhubarb of Pontus, a province of Asia Minor; M. L. Rheum rhaponticum

Description from Metcalfe, Ann. of Appl. Biol., 27, 1940, 502, where he suggests it belongs in Erwinia.

Rods: 0.5 to 0.8 by 1.2 to 1.5 microns. Motile with 3 to 7 peritrichous flagella. Gram-negative.

Gelatin stab: Beaded growth. No liquefaction.

Infusion agar: Colonies circular, convex. smooth, elistening, translucent

vex, smooth, glistening, translucent, with margins entire, 2 to 3 mm in diameter in 48 hours at 25°C.

Rhubarb agar: Colonies slightly larger, often with a yellowish tinge.

Tryptophane broth: Turbid with fragile pellicle, a slight rim and slight floculent deposit.

Milk: Acid in 3 to 4 days with or with-

out slight curd separation. No clotting. Indole not produced.

Nitrites formed from nitrates.

Acetylmethylcarbinol produced. No hydrogen sulfide produced.

Cohn's solution: Moderate growth.

Acid but no gas from arabinose, xylose,

Acid but no gas from arabinose, xylose, glucose, galactose, fructose, mannose, lactose, maltose, sucrose, mannitol, glycerol and salicin.

Growth in citrate solution Starch not hydrolyzed,

Chromogenesis: Water-soluble pinkish nigment in various media.

Growth from 0°C to 37°C and possibly higher.

Distinctive characters: Differs from Erwinia aroideae in that it does not liquify gelatin nor clot milk and is chromogenic. It also has a limited host range.

mogenic. It also has a limited host range. Source: From rotting rhubarb crowns. Matcalfe used 6 isolates from various sources in describing the pathogen.

Habitat: Causes a crown-rot of rhubarb.

21. Erwinia lathyri (Manns and Taubenhaus) Holland, (Besilius lathyri Manns and Taubenhaus, Gardener's Chroniele, 55, 1913), 215; Manns, Delaware Agr Exp. Sta., Bul. 108, 1015, 23; Bac-Holland, Jour Bact., 5, 1920–218; Bac-

terium lathyri Burgwitz, Phytopath. Bacteria, Leningrad, 1935, 76.) From the genus Lathyrus.

Rods: After 24 hours at 25° to 25°C, 0.6 to 0.85 by 0.75 to 1.5 microns, with rounded ends. No capsules. Motile with peritrichous flagella. Gram-negative.

Gelatin colonies: After 8 days, circular, slightly convex, edges smooth Liquefaction too slow to show on plate.

Gelatin stab: Growth best at surface Line of stab filiform. Liquefaction slow, fairly well begun in four weeks, complete in three months.

Agar colonies: After 24 hours, yellow, stellate to amoeboid, smooth, glistening, slightly raised, entire. Centers granular, yellow.

Agar slant: Growth fillform, slightly convex, smooth, glistening, opaque, butyrous, light to deep yellow. Odor absent.

Broth: Strong turbidity in 24 hours, little or no pellicle. Sediment scant.

Litmus milk: Slow increase of acidity, not always sufficient to cause coapulatoa. Digestion of casein slow and varsule. Potato: Growth rapid, filiform, sughtlyconvex, smooth, glistening, butyrous t slightly viseid. Light to deep yellow Medium not discolored.

Indole is formed.

Cohn's solution: No growth.

Uschinsky's solution: Rapid growth sometimes a pellicle. Fluid viscid.

Asparagine solution: Good growth. Nitrites are not produced from ni

Ammonia produced in broth and as-

paragine solution.

No gas from carbohydrates. Acid
from glucose, lactose, sucrose, mannitel
from glucose, lactose, sucrose, mannitel

and glycerol. No growth in closed arm Diastase not formed or extremely

Growth in broth over chloroform

Growth inhibited by 4 per cent NaCl Temperature relations: Optimum 23° to 30°C. Thermal death point 46° to

Anrohan

Source: From sweet peas.

Habitat: Stated to be pathogenic for sweet pea (Lathyrus odoratus) and other legumes. Considered by many to be a sapprophyte.

22. Erwinia ilili (Uyeda) Magrou. (Bacillus Ilili (Uyeda, by Bokura, Ann Phytopath. Soc. Japan, 1(2), 1919, 36, Magrou, in Hauduroy et al., Diet d. Bact. Path., 1937, 210.) From Latin Ilium, a name taken from the Greek but derived from the Celtic word li meaning white. M. J. energie name. Lilium

Translated by Marion Okumoto. Rods: 0 6 to 0.7 by 0.8 to 1 0 micron.

Rods: 0 6 to 0.7 by 0.8 to 1 0 micron. No capsules. Motile with 6 to 8 pertrichous flagella. Gram-positive(?)

Gelatin · Liquefaction.

Gelatin plate Colonies after 2 days, round and smooth with grayish surface Broth: Alkaline, ammonia produced.

Milk. Curd formation.

Indole produced.

Nitrites produced from nitrates. Hydrogen sulfide produced.

Sugar medium changes to a brown color Conne not utilized.

Aerobie, facultative.

Optimum temperature 32° to 34°C. Killed in 3 min at 50°C. Resists—20°C for 30 min

Source: From brown spots on Isly bulbs in Japan.

In Japan.

Habitat: Causes a disease of hily bulbs and leaves.

Appendix: The following additional species are found in the literature. Many are incompletely described.

Bacillus brassicatiorus Delacroix (Compt rend Acad. Sci., Paris, 140, 1905, 1356.) Presumably causes a rot of cabbace.

Eucilius farnetianus Pavarino. (Atti R. Accad. Naz. Lincol Rend Cl. Sci. Fis., Mat. e Nat., 20, 1911, 233.)

Bacillus putrefaciens putridus Dela-

croix. (Ann. Inst. Nat. Agron., 5, 1906, 154.) Pathogenic for tobacco.

Bacillus solaniperda Migula. (Syst. d. Bakt., 2, 1900, 573; Bacillus krameri Chester, Man. Determ. Bact., 1901, 282). Causes a soft rat of rotato.

Bacillus spiechermanni Jacsewski. (Elliott, Bacterial Plant Diseases, 1935, 67.) Name applied to a species described by Spiechermann (Landw. Jabrb., \$7,1002, 155.) but left upgarped.

Bacillus tabacivorus Delacroix. (Ann. Inst. Nat Agron., 5, 1906, 266.) Said to cause collector of tobacco.

Bacillus tabificans Delacroix. (Compt. rend. Acad. Sci., Paris, 157, 1903, 871.)
Said to cause spotting of tobacco leaves.

Bacterium lochnisi Kalantarian. (Kalantarian, Cent. f. Bakt., II Abt., 65, 1925, 301; Phylomonas lochnisi Bergoy et al , Manual, 3rd ed., 1930, 276.) From diseased cotton plants Peritrichous.

Bacterium lycopersici Burgwitz. (Zischr f. Pflanzenkr., 54, 1924, 301.) From a blossom end rot of tomato

Erwinia alliariae (Omori) Magrou. (Bacillus alliariae Omori, Official Gaz. of Japan, 11, 1809, No. 3755; Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 195) Causes a root rot of horseradish.

Erusnia araliatora (Uyeda) Magrou. (Bacillus araliatorus Uyeda, Bull. Imp. Agr Exp Sta Tokyo, 55, 1909, 61; Magrou, in Hauduroy et al., Dict. d. Bact. Path., 1937, 197.) Causes a root rot of ginseng.

Erenna asteracarum (Pavasino) Magrou. (Bacillis asteracarum Paravino, Atti R. Accad. Naz. Lincei Rend. Cl. Sci Fis., Mat. e Nat., Ser. 5, 21, 1012, 544, Magrou, in Hauduroy et al., Dict. d Bact. Path., 1937, 199) Pathogenio for the aster (Aster chinensis).

Ericuna bussei (Migula) Magrou. (Bacillus B, Busse, Zische f. Pflanrenkr, 7, 1897, 74; Racillus busser Migula, Syst. d. Bakt., 2, 1900, 779; Bacillus betae Lehmann and Neumann, Bakt. Diag., 4 Auft., 2, 1907, 599; not Bacillus betae Migula, Syst. d. Bakt., 2, 1900, 779; Magrou, in Hauduroy et al., Dict. d. Bact. Path., 1937, 200.) Pathogenic for the sugar beet.

Erwinia cacticida (Johnston and Hitchcock) Magrou. (B. cacticidus Johnston and Hitchcock, Trans, and Proc. Rov. Soc. South Australia, 47, 1923, 162; Magrou, in Hauduroy et al., Diet. d. Bact. Path., 1937, 201.) Causes a rot of cactus.

Erwinia edgeworthiae (Hori and Bokura) Magrou, (Bacillus edaeworthiae Hori and Bokura, Ideta Arata, Supplement to Handbook of the Plant Diseases of Japan, 1, 1925, 32; Magrou. in Hauduroy et al., Dict. d. Bact. Path., 1937, 206.) Pathogenic on Edgeworthia chrusantha, an oriental shrub.

Erwinia imae (Severim) Magrou. (Bacillus sziae Severini, Annali di Botanica, Rome, 11, 1913, 413; Magrou, in Haudurov et al., Dict. d. Bact. Path., 1937, 208.) Pathogenic on gladiolus and other bulbs.

Erwinia nelliae (Welles) Magrou. (Bacillus nelliae Welles, Philippine Jour. Sci., 20, 1922, 279; Magrou, in Hauduroy et al . Dict. d. Bact. Path., 1937, 213.)

Erwinia papayae (Rant) Magrou, (Bacillus papayae Rant, Cent. f. Bakt., II Abt., 84, 1931, 483; Magrou, in Hauduroy et al., Dict d. Bact Path , 1937, 214.) Pathogenic on papava.

Erwinia sacchari Roldan. (Philippine Agric., 20, 1931, 256; Bacıllus saccharum Roldan, idem: not Bacillus sacchari

Janse, Mededeel, uit's Lands, Planten. tuin, 0, 1891, 1.)

Erwinia scabiegena (von Faber) Ma grou. (Bacterium scabiegenum von Faber. Arb. Kais. Biol. Anst. f. Land u Forstw., 5, 1907, 347; Bacillus scabiegenus Stapp, in Sorauer, Handb. d. Pflanzenkr. 5 Aufl., 2, 1928, 103; Magrou, in Hauduros et al., Dict. d. Bact. Path., 1937, 217.) Pathogenic for the beet (Beta sulgaris) Erwinia serbinowi (Potebnia) Magrou (Bacterium beticola Serbinow, Zhurm) Bolezni Rastenii, 7, 1913, 237; not Bacterium beticola Smith, Brown and Tonasend, Bur. Plant Ind., U. S. Dept. Agr, Bul. 213, 1911, 194; Bacterium serbinovi Potebnia, Kharkov Prov. Agr. Exp Sta, 1, 1915, 1; Bacillus beticola Stapp, in Sorauer, Handb. d. Pflanzenkr, 5 Aufl, 2. 1928, 93; Bacillus serbinowi Elliott, Man. of Bact. Plant Pathogens, 1930, 75, Magrou, in Hauduroy et al , Dict. d Bact. Path., 1937, 217.) Pathogenic for

the sugar beet. Erwinia urae (Kruse) Magrou. (Bacillo della bacterosidei grappoli della vite, Cugini and Macchiati, Le Stazione sperimentali ital., 20, 1891, 579; Bacellus uvae Kruse, in Flugge, Die Mikroorgamsmen, 3 Aufl., 2, 1896, 329; Bacterium uvae Chester, Ann. Rept. Del. Agr. Exp Sta., 9, 1897, 53 and 127; Magrou, in Hauduroy et al., Dict. d. Bact. Path, 1937, 220.) Pathogenic for the grape

Erwinia vitavora du Plessis syn Clestridium baccarınii Bergey et al , Manusl, 1st ed., 1923, 328

### TRIBE III, SERRATEAD BERGEY, BREED AND MURRAY.

(Preprint, Manual, 5th ed , October, 1938, vi.)

Small, aerobic rods, usually producing a bright red or pink pigment on agar and gelatin. There is a single genus.

### Genus I. Serratia Bizio emend. Breed and Breed.\*

(Bizio, Biblioteca italiana o sia Giornale de lettera, scienze e arti, 30, 1823, 288, Zaogalactina Sette, Sull'arrossimento straordinario di alcune sostanze alimentose osservato nella provincia di Padova l'anno 1819. Venezia, 1824, 51, Gecebacterium Schmidt and Weis, Die Bakterien, 1902, 10, Erghrobactillus Fortineau, Compt rend. Soc. Biol., Paris, 58, 1905, 101, Dierobactium Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 309, Breed and Breed, Cent f Bakt., II Abt., 71, 1927, 435. Named for Scrafino Serrati, the Italian physicist who invented a steam boat at Florence before 1787.

Small, aerobic, rapidly liquefying, mitrate reducing, Gram-negative, peritrichous rods which produce characteristic red pigments. White to rose-red strains that lack brilliant colors are common. Cosgulate and digest milk. Liquely blood serum. Typical species produce CO<sub>2</sub> and frequently H<sub>2</sub> from glucose and other sugars; also acetic, formic, succinic and lactic acids, acetylmethy learbinol and 2,3 butylene glycol Saprophytic on decaying plant or even animal materials

The type species is Serratia marcescens Bizio

### Key to the species of genus Serratia.

- I. Pigment not especially water-soluble, readily soluble in alcohol.
  - A. No visible gas from glucose
    1. Inconspictous pelluce, if any, on plain gelatin
    - 1 Serratia marcescens.
    - 2 Brilliant orange-red pellicle on plain gelatin
      2 Serratia indica-
  - B Produce enough H2 with the CO2 from glurose to show gas in fermentation
    - 1. Acetylmethylcarbinol produced
- 3 Serratia plymuthicum.
- 2. Acetylmethylcarbinol not produced
  4 Serratia kilensis.
- II Pigment soluble in water and alcohol
  5 Serratia piscatorum.
- 1. Serratia marcescens Bizio (Polenta porporina, Biblioteca italiana, 30, 1823, 289) From Latin, dissolving into a fluid or viscous matter

Synonyms: Zoagalactina imetrofa

Sette, Memoria storico-naturale sull' arrossimento straordinario di alcune sostante alimentose Venezia, 8°, 1821, 51; Protococcus imetrophus Meneghini, 1838, see Trevisan, Rend. R. Inst. Lomb.

<sup>\*</sup> Revised by Prof. Robert S Breed, New York State Experiment Station, Geneva, New York, Nov., 1937, further revision by Prof. Robert S. Breed, Nov., 1945.

di Sci. e Let., Ser. 2, 20, 1887, 797; Monas prodigiosa Ehrenberg, Bericht u. d. z. Bekanntmachung geeigneten Verhandlungen d. Kgl. preuss. Acad. d. Wissenschaften, 1849, 354; Palmella prodigiosa Montague, Bul. Soc. nat. et cent. d. agric. Paris, Sér. 2, 7, 1853, 527; Micraloa prodigiosa Zanardini, 1863, sec Trevisan, loc. cit., 1887, 799; Bacteridium prodigiosum Schroeter, in Cohn, Beiträge z. Biol. d. Pflanzen, 1, Heft 2, 1872, 109; Micrococcus prodigiosus Cohn, ibid., 127: Bacillus prodigiosus Flugge, Die Mikroorganismen, 1886, 284; Bacillus imetrophus Trevisan, loc. cit., 797; Bacillus marcescens De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 976; Bacterium prodigiosum Lchmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 259; Liquidobacterium prodigiosum Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 339; Erythrobacillus prodigiosus Winslow et al., Jour. Bact., 5, 1920, 209; Dicrobactrum prodigiosum Enderlein, Bakterien Cyclogenie, 1925, 279; Salmonella marcescens and Salmonella prodigiosa Pribram, Jour. Bact., 18, 1929, 384; Chromobacterium prodigiosum Topley and Wilson, Principles of Bacteriology, 1, 1931, 402.

Description largely taken from Breed and Breed, Jour Bact., 9, 1924, 545.

Short rods, sometimes almost spherical: 0.5 by 0.5 to 1.0 micron, occurring singly and occasionally in chains of 5 or 6 elements. Mottle, with four pericihous flagella. Eight to ten flagella on cells grown at 20° to 25°C (De Rossi, Rivista d'Igiene, 14, 1903, 000). Gramnegative.

Gelatin colonies: Thin, slightly granular, gray becoming red, circular, with slightly undulate margin. Liquefy the medium rather quickly.

Gelatin stab: Infundibuliform liquefaction. Sediment in liquefied medium usually red on top, white in the depth.

Agar colonies: Circular, thin, granular, white becoming red. R and S colonies

with mucoid variants (Reed, Jour. Bact., 84, 1937, 255).

Agar slant: White, smooth, moist layer, taking on an orange-red to fuchsin color in three or four days, sometimes with metallic luster.

Broth: Turbid, may form a red ring at surface or slight pellicle, and gray sediment.

Litmus milk: Acid reaction with soft coagulum. A red surface growth develops. Little or no digestion takes place.

Potato: At first a white line appears, which rapidly turns red. The growth is luxuriant and frequently shows a metallic luster.

Produces acetic, formic, succihic and levolactic acid, ethyl alcohol, acetyl-

water containing urea, potassium chlonde and glucose.

Indole not produced.

Nitrites produced from nitrates.

Formation of H<sub>2</sub>S: Produced from Citiene, cystine or organic sulfur compounds containing either of these molecules. Produced from sulfur but not from sulfites, sulfates or thiosulfates (Tarr, Biochem Jour., 27, 1933, 1869; 28, 1934, 192).

Acetylmethylcarbinol is produced (Breed).

Pigment soluble in alcohol, ether, chloroform, benzol and carbon bisulfide (Schneider, Arb. Bakt. Hochsch. Karlstube, I, 1894, 210). Pigment may diffuse through the agar, i e, shows solubility in water where strains are very deeply pigmented (Breed). Pigment not formed at 35°C.

Sodium formate broth (Stark and England, Jour. Bact., 29, 1935, 26); Cultures do not produce visible gas (Breed).

Odor of trimethylamine is produced. Aerobic, facultative. Optimum temperature 25° to 30°C.

No growth at 37°C.

Source Described by Burio (for at)

Source: Described by Bizio (loc. et.) and Sette (loc. cit.) from growth on corn meal mush (polenta).

meal mush (polenta).

Habitat: Water, soil, milk, foods, silk
worms and other insects

2. Serratia indica (Eisenberg) Bergey et al. (Bacillus indicus Eisenberg, Bakt. Diag., 1 Aufl., 1886, 1; Bacillus indicus ruber Flugge. Die Mikroorganismen, 2 Aufl., 1886, 285; Micrococcus indicus Koch, Berichte ueber die Reise zur Erforschung der Cholera, 1887, Bacillus ruber indicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 302; Bacterium ruber indicus Chester, Ann. Rept. Del. Col Agr Exp Sta , 9, 1897, 112; Erythrobacillus indieus Holland, Jour. Bact., 5, 1920, 218, Bergey et al., Manual, 1st ed., 1923, 88, Breed and Breed, Jour of Bact , 11, 1926, 76, Chromobacterium indicum Topley and Wilson, Princ Bact and Immun, I, 1931, 402.) From Latin indicus, of India.

Small rods: 0.5 by 10 to 15 microns
Motile with four peritrichous flagella
Gram-negative.

Gelatin colonies: Resemble those of Serratia marcescens.

Gelatin stab, Liquefied rather quickly Brilliant orange-red pellicle on plain gelatin.

Agar colonies. Pink, with slightly serrate margin, spreading, with green irridescence.

Agar slant: Luxuriant, dirty-white layer. Pigment produced best in alkaline media.

Broth: Turbid, with white sediment Litmus milk: Acid and congulated

Digestion complete in 10 days. Potato; Luxuriant growth with or with-

out pigment formation.

Produces same products (except H<sub>2</sub>)
from clucose as does Serratia marcescens

(Pederson and Breed, Jour. Bact., 16, 1928, 183).

Indole not produced.

Nitrites produced from nitrates. Growth with pigment production in distilled water containing urea, potassium chloride and glucose.

Blood serum liquefied. Odor of trimethylamine.

Sodium formate broth · Cultures do not produce visible gas (Breed).

Pathogenic for laboratory animals. Acetylmethylcarbinol is produced (Breed).

Aerobic, facultative.

Optimum temperature 25° to 35°C.

No growth at 37°C.

Cultures of this organism lose their
ability to produce the orange-red pellicle

ability to produce the orange-red pellicle on gelatin and then become practically indistinguishable from cultures of Seratia marcescens. This would indicate that this so-called species is a rough strain of the former species (Breed). See Reed (Jour. Bact, 31, 1937, 255) for a discussion of dissociation phenomena in this genus.

Source. Isolated from alimentary tract of a Java ape in India; also from milk can from Ithaca, N. Y.

Habitat. Presumably widely distributed.

Apparently the following non-gelatin iquefying strain belongs with this species Subcultures that are claimed to be derived from the original now inquely relatin.

2a. Serratia miquelti Bergey et al. (Named Bacillus ruber by Miquel and described in a letter to Hefferan, Cent. f. Bakt. II Abt. II. 1903, 402; Erythrobacillus ruber Holland, Jour. Bact., 6, 1920, 223; Bergey et al., Manual, 1st ed., 1923, 95)

Isolated from water by Miquel.

3. Serratia plymuthicum (Lehmann and Neumann) Bergey et al. (Roter Bacillus aus Plymouth, Fischer, Zeitschr.

f. Hyg., 2, 1887, 74; Bacterium plytmuthicum Lehmann and Neumann, Bukt.
Ding., 1 Aufl., 2, 1896, 264; Bacillus plymouthensis Migula, Syst. d. Bakt., 2, 1900, 819; Erythrobacillus plymouthensis Holland, Jour. Bact., 5, 1920, 220; Bergey et al., Manual, 1st ed., 1923, 88.) Latinized from Plymouth, England.

Distinct rods: 0.6 by 1.5 to 2.0 microns with rounded ends, occurring singly and in short chains. Motile with peritrichous flagella. Gram-negative.

Gelatin colonies: Like Serratia marcescens. Original culture mucoid. Gelatin stab: Crateriform liquefaction.

Liquefaction as in Serratia marcescens.

Agar colonies: Like mucoid varieties of Serratia marcescens.

Agar slant: Sometimes show metallic luster. Pigment as in Serratia marcescens.

Broth: Like Serratia marcescens.

Litmus milk: Acid and coagulated. Potato · Growth violet pink, with or

without metallic luster.

Gas from glucose, lactose and sucrose,
70 to 80 per cent of it CO<sub>2</sub> Remainder
is H<sub>2</sub> Gas is also produced in asparagine

solutions.
Strong fecal odor produced.

Blood serum liquefied.

Acetylmethylcarbinol is produced (Breed).

Sodium formate broth: Cultures produce abundant gas (Breed).

Pigment soluble in alcohol, ether and sometimes water.

Aerobic, facultative.

Optimum temperature 30°C.

Source: From water supply of Plymouth, England.

Habitat: Water and various foods.

 Serratia kilensis (Lehmann and Neumann) Bergey et al. (Bacterium h, Breunig, Inaug. Diss., Kiel, 1888; Bacillus ruber ballucus Kruse, in Fluggo, Die Makroorganismen, 3 Aufl., 2, 1890, 303; Bacterium kiliense Lehmann and Neumann, Bakt. Diag., I Aud., 2, 1806, 263; Bacterium ruber baltieus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 142; Bacillus kitiensts Migula, Syst. d. Bakt., 2, 1900, 847; Erythrobacilus kitiensis Ilollund, Jour. Bact., 6, 1920, 218; Bergey et al., Manual, 1st ed., 1923, 90; Chromobacterium kielense Topley and Wilson, Princip. Bact. and Immun., 1, 1931, 400.) From Kiel, a city on the Baltie Sea.

Description taken from Kruse (loc cit.) and Bergey et al. (loc. cit.).

Slender rods: 0 7 to 0.8 by 2 5 to 50 microns, occurring singly. Mottle with four peritrichous flagella. Gram-negative

Deep gelatin colonies: Bright yellow Gelatin liquefied slowly, usually becoming rose-red.

Glucose gelatin stab: Rapid liquefaction. Occasional gas bubbles (Breed) Agar colonies: Small, red becoming magenta, smooth.

Agar slant: Bright red becoming darker in old cultures

Agar stab: Turbid strongly pigmented water of condensation.

Broth: Turbid. Usually reddened. Litmus milk: Acid; at 20°C, coagulated slowly and pigment produced; at 35°C, coagulated rapidly and no pigment produced.

Potato: Slight red growth, becoming luxuriant and darker.

Indole not formed.

Nitrites and free nitrogen produced from nitrates.

Blood scrum liquefied.

Acid and gas from carbohydrates (Lehmann and Neumann, loc. cit.). Gas from glucose, lactose and sucrose, 20 to 30 per cent of it CO<sub>2</sub> (Bergey). Inactive lactic acid produced and not more than a trace of acctylmethylcarbinol or 2, 3 butylene glycol (Pederson and Breed, Jour. Bact., 16, 1928, 183).

Sodium formate broth: Gas produced (Breed).

Acetylmethylearbinol not produced by the Král culture (Breed)

Pigment formed at 37°C Pigment especially soluble in alcohol Ontinum temperature 20°C

Aerobie

Distinctive characters. It is not cartain whether Brennig's original culture was a heavily nigmented strain of Serratia marcescens, or whether it was of the type described above. Cultures of both types have been widely distributed as the Kiel bacillus Descriptions drawn up by Kruse (loc. est.) and Lehmann and Neumann (loc cit ) in 1896 state that this bacterum produces visible cas, while Migula in 1900 gives a description which fits Serratia marcescens Moreover, cultures obtained under this name from various laboratories in Furane and America are sometimes of one type and seme times of the other As the Král culture distributed as Recellus cuber balticus 18 widely known and has now been shoun to differ from Serratia marcescens in that it is a distinct rod in ordinary media, forms visible gas from earbohydrates and even more abundant gas from sodium formate media, the name Serratia kilensus is used here for the Král culture Serratia Lilengie is a distinct rod like Serratia plymuthroum, but fails to produce acets1methylcarbinol. This use of the name Serratio Lileness given here also accords with the description drawn up by Bergey for the first edition of the Manual based on the study of a culture which he abtained many years previously from Lurope (Breed).

Source: From nater at Kiel, Germany Habitat: Presumably widely dis

inhuted

5 Serratia viscatorum (Lehmann and Neumann) Breed (Microbe rouge de la sardine, Du Bois Saint-Sévrin, Ann Inst Past., 8, 1894, 155, Bacterium piscalorum Lehmann and Neumann, Bakt Ding , 1 Auff , 2, 1896, 263, Bacillus ruber gards nge Kruse, in Fiftere, Die Mikrootganis-

men. 3 Aufl. P. 1596 302 · Racterium ruber sardings Chester, Ann. Ront Del Col. Age Exn. Sta., 9, 1897, 112, Bacellus sardinas Migula, Syst. d. Balt. 2 1900 853. Bacillus mecatorus Chaster Mon Determ. Bact. 1901 257 ) From Latin niscotorum of fishermen

Short rads: 0.5 by 0.6 micron, occurring in pairs, sometimes in fours or (in broth) in long filaments. Actively motile. Gram-negative.

Gelatin colonies Small, vellon ish-gray becoming pink, very slimy. Carmineted pellicle. Liquefaction

Goldtin etch Rapid honefaction. Gravish nellude which becomes red after 24 hours and later preciminates Slowy

Agar colonies Dull, white to pinkish oron th

Broth Rapid turbidity. Thick, slimy. white pellicle which later turns red. Purplish sediment Liound becomes pink and syrupy. In old cultures the

landh is brown Poteto At 37° to 39°C, red nigment visible after 8 hours. At room temperatures growth is first white, slimy, later

red. Strong odor of trimethylamine.

Distinctive characters: Piement soluble in alcohol, more soluble in water Good pigment production at 37°C. Slimi-

Source Isolated in 1893 from a box of oil-nacked sardines at a canning-factory in France Also found in the red pus from fishermen and sardine-factoryworkers suffering from felons. In these lesions, this organism is associated with an anaerobe, but by itself it is not nathogenie

Habitat Presumably widely tributed

Appendix: Serratia murcescens has frequently been described under other names, particularly where brilliantly premented cultures have been found Some of these and other related species are listed below. It is known that white

strains of these organisms occur in nature but these strains when found have probably been placed in non-chromogenic genera of the family Enterobacteriaceae.

Bacillus ruber Frank, (Frank, in Cohn, Beitr. z. Biol. d. Pflanz., I, Heft. 3, 1876, 181; not Bacillus ruber Zimmermann, Bakt. unserer Trink- u. Nutzwässer, Chemnitz, I, 1890, 24; not Bacillus ruber Miquel, see Cent. f. Bakt., II Abt., II, 1903, 402; Bacterium ruber Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 113.) Grew in a warm place on rice cooked in chicken both.

Bacillus subkiliensis Petrow. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 273.) Dust contamination from air. Reported to resemble Bacillus kiliensis.

Bacterium aurescens Parr. (Proc. Soc. Exp. Biol. and Med., 35, 1937, 563). A reddish-brown organism. This and the reddish-orange organism described by Tittsler (Jour. Bact., 33, 1937, 450), which are regarded as pigmented variants of Escherichia coli, resemble the organisms in Serratia closely but do not liquefy gelatin. From water.

Seratia amylorubra (Hefferan) Bergey et al. (Bacillus amyloruber Hefferan, Cent. f. Bakt., II Abt., 11, 1903. 313; Erythrobacillus amyloruber Holland, Jour. Bact., 5, 1920, 217, Bergey et al., Manual, 1st ed., 1923, 90) From Mississippi River water and buttermilk.

Serratia esseyana Combe. (Thèse, École de Méd. Univ. Besançon, 1934, 1.) From well water at Essey. A study of an authentic culture shows this to be Serratia marcescens (Breed).

Serratia fuchsina (Boekhout and De Vries) Bergey et al. (Bacıllus fuchsinus Boekhout and DeVries, Cent. f. Bakt., II Abt., 4, 1898, 497; Erythrobacillus fuchsinus Holland, Jour. Bact., 6, 1920, 218; Bergey et al., Manual, 1st ed., 1923, 91.) Bacıllus fuchsinus Migula. (Der rote Bacıllus, Lustig, Diag. d. Bakterien d. Wassers, 1803, 72; Migula, Syst. d. Bakt., 2, 1900, 833.) Although these two organisms were named independently

from different cultures, they were undoubtedly identical. The original cultures of these species appear to have been heavy pigmented strains of Serratia marcescens showing a metallic luster. No authentic cultures are available. From water.

Serratia gutturis Jan. (Bull. Soc. Sci. de Bretagne, 16, 1939, 34.) From sputum. Claimed to be different from Serratia marcescens on the ground that it will grow on an asparagine medium and that it reduces molybdates actively.

Serratia marinorubra Zobell and Upham. (Bull. Scripps Inst. Oceanography, LaJolla, 5, 1914, 255) From sea water. Grew only on sea water media when first isolated but later a culture studied by Breed (1944) became adapted to growth on ordinary media and then showed the characteristics of Serratia marcescens.

Serratia miniacea (Zimmermann) Bergey et al. (Bacillus miniaceus Zimmermann, Die Bakterien unserer Trink- und Nutzwässer, Chemmitz, J. 1890, 46; Erythrobacillus miniaceus Holland, Jour. Bact., 5, 1920, 219, Bergey et al., Manual, 1st ed., 1923, 90.) Probably a heavily pigmented strain of Serratia marcescens or Serratia plymutheum showing metalic luster. From water.

Serratia pyoseptica (Fortineau) Bergey et al. (Erythrobacillus pyosepticus Fortineau, Thesis, Faculty of Medicius, Paris, 1904; abstract in Bull. Inst Pasteur, 3, 1905, 13; Bergey et al., Manual, alt ed., 1923, 89.) No constant differences have been detected between Serratia marcescens and authentic cultures of Serratia pyoseptica. From the shirt of a hospital patient. Pathogenic for guinea pigs and birds. Forms a soluble toxin.

Serratia rubidaea Stapp. (Bacterium rubidaeum Stapp, Cent. (. Bakt., II Abt., 102, 1940, 251; 15td., 253) From surface of plants and in composts. Characters much like those of Seratia marcescens.

Serratia rutilescens (Hefferan) Bergey et al. (Bacillus rutilescens Hefferan, Cent. f. Bakt., II Abt., II, 1903, 313, Erythrobacullus rutilescens Holland, Jour. Bact., §, 1920, 220; Bergey et al., Manual, 1st ed., 1923, 91.) The characters given do not distinguish this species from strains of Serratia marcescens that have nearly lost their power of pigment production except that it is reported to grow rapidly at 37°C. No authentic cultures appear to be available. From Mussissuppi Piirer, batter.

Scratia rutilis (Hefferan) Bergey et al. (Bacıllus rutilis Hefferan, Cent. f. Bakt., II Abt., 11, 1903, 313, Erythrobacillus rutilis Holland, Jour. Bact., 6, 1920, 220; Bergey et al., 1st ed., 1923, 94.) The original of this species appears to have been a heavily pigmented strain of Serratia marcescens or of Serratia plymuthicum. No characters are given that distinguish it from these species and no cultures appear to be available. From Hinnis River mater.

Serratia stercoraria Jan. (Bull. Soc. Sci. de Bretagne, 16, 1939, 34) From feces. Claimed to be different from Serratia marcescens because it attacks alactose, maltose and mannitol and reduces molybdates even more actively than Serratia autturit.

## TRIBE IV. PROTEAE CASTELLANI AND CHALMERS.

(Manual of Trop. Med., 3rd ed., 1919, 932.)

Ferments glucose but not lactose with formation of acid and usually visible gas. There is a single genus.

## Genus I. Protens Houser \*

(Hauser, Sitzber. d phys.-med. Sozietat zu Erlangen, 1885, 156; Liquidobacterium Jensen, Cent. f. Bakt., II Abt., 22, 1909, 337; Spirilina Hueppe, Wiesbaden, 188, 146; Eisenbergia Enderlein, Sitzber. Ges. Naturf. Freunde, Berlin, 1917, 315.) From Latin, having a changeable form.

Straight rods. Gram-negative. Generally actively motile at 25°C, motility may be weak or absent at 37°C, petitrichous, occasionally very numerous flagella. Generally produce amoeboid colonics, swarming phenomenon, on moist medium. Marked ples morphism characteristic only of very young, actively swarming cultures. Femeat glucose and usually sucrose but not lactose. Three species in fermentable carbohydrates produce small gas volumes even after prolonged incubation and an occasional culture does not produce gas. One species usually produces acid only. Urea decomposed and trimethylamine oxide reduced by all species

The type species is Proteus sulgaris Hauser.

## Key to the species of genus Proteus.

- I. No action on mannitol.
  - A Acid and gas from sucrose.
    - 1. Acid and gas from maltose.
      - u >114010 10111-0-1
- Proteus vulgaris.
- B. Acid and gas from sucrose (delayed).
  - 1. No action on maltose
    - a Indole not formed.
- 2. Proteus mirabilis.
- C. No action on sucrose (ordinarily).
  - 1. No action on maltose.
    - a. Indole formed.

- 3. Proleus morganii.
- II. Acid, occasionally a bubble of gas, from mannitol.
  - A Acid from sucrose (delayed)

    1. No action on maltose.
    - a. Indole formed.
      - a. moole formed.

4. Proleus religeri.

 Proteus vulgaris Hauser. (Hauser, Sitzungsber. d. phys.-mediz Sozietat zu Erlangen, 1885, 156, Bacillus proteus Trevisan, I generi e le specie delle l'atternacce, 1889, 17; Bacterium sulgare Lehmann and Neumann, Bakt. Disg.

<sup>\*</sup> Originally revised by Prof M. W. Yale, New York State Experiment Station, Geneva, New York, Nov , 1938; revised by Prof. C A. Stuart and Dr. Robert Rusligian, Brown University, Providence, Rhode Island, May, 1943

1 Aufl., 2, 1896, 243; Bacillus proteus tulgaris Kruse, in Flugge, Die Mikroorganismen, 2, 1896, 272, Bactersum (Proteus) vulgaris Chester, Ann Rept Del. Col. Agr. Exp. Sta , 9, 1897, 101, Bacıllus vulgarıs Mıgula, Syst d Bakt, 2, 1000, 707; Bactersum proteus anin dologenes van Loghem, Ann. Inst Past . 32, 1918, 295; Bacillus proteus-vulgaris Holland, Jour. Bact., 5, 1920, 220.) From Latin, common.

Hauser described Proteus vulgaris as a rapid gelatin liquefier and Protous mirabilis as a slow liquefier Wenner and Retiger (Jour. Bact , 4, 1919, 332) found the property of liquefying gelatin too variable to serve as a basis for separation of species. They suggested that this differentiating character be set aside and the two species differentiated on the basis of maltose fermentation, the species fermenting the sugar receiving the name Proteus vulgaris and the species failing to attack it, Proteus mirabilis suggestion was accented by Bergev et al . Manual, 1st ed., 1923 and Weldin, Ions Jour. Sci , 1, 1927, 147, and their work was confirmed by Rustigian and Stuart (Jour. Bact., 45, 1913, 198) and by Thornton (Jour. Bact , 48, 1944, 123) Also see Moltke (Contributions to the Characterization and Systematic Classification of Bac proteus vulgaris (Hauser), Levin and Munksgaard, Copenhagen, 1927, 156).

Rods · 0.5 to 1.0 by 1 0 to 3 0 microns, occurring singly, in pairs and frequently in long chains. Actively motile, with

peratrichous flagella Gram-negative Celitin colonies Irregular, spreading,

rapidly liquefying. Gelatin stab . Rapid, stratiform liquefaction.

Agar colonies · Opaque, gray, spreading Agar slant. Thin, bluish gray, spreading over entire surface

Broth: Marked turbidity, usually with a thin pellicle.

Litmus milk: Shehtly acid, becoming

markedly alkaline. Quick peptonization

Potato: Abundant, creamy to rellowish gray growth, becoming brown. Indole formed.

Nitrites produced from nitrates. Acetylmethylcarbinol not formed

Acid and gas from glucose, fructose, galactose, maltose and sucrose No acid or gas from dextrin, lactore or mannitol. See Moltke (loc. cit.) for other ferments. tion characters Ratio II, to CO, is 1:1 (Speck and Stark, Jour Bact., 44, 1942, 687)

Putrefactive odor produced. Sodium citrate usually utilized as sole source of carbon.

Formation of H-S: Produced from eysteine, eystine or organic sulfur compounds containing either of these molecules Produced from sulfur and thiosulfates (Tarr. Biochem. Jour., 27, 1933. 1869, 28, 1934, 192). Lead acetate turned brown.

Aerobic, facultative.

Optimum temperature 37°C

Distinctive characters . X-Strains of Weil and Felix. Lehmann-Neumann-Breed, Determinative Bact , Eng. Trans. 7th ed . 2, 1931, 493 "The discovery of proteus strains which may be agglutinated by typhus scrum is of very great importance. These are the so-called X-strains from typhus patients found by Weil and Felix. They first cultivated strains X and X2 from the urine of typhus nationts and later the famous Xis. The two former were agglutinated weakly, the latter strongly (up to 1:50,000). The diagnosis of typhus by applutination with strain Xi proved to be excellent and the reaction took place in the serum of almost 100 per cent of those suffering from the disease . . The typhus strains of proteus have recently been divided into the tun types of Februard West, the II forms and the O forms. The former grows as a thin oraque film, the Litter lacks this character and grows as non-spreading slimy colonies; frequently nithout distinct flagella..." (For further description of H and O forms see Moltke, loc. cit.)

The X<sub>2</sub> and X<sub>12</sub> strains mostly ferment maltose.

Source: From putrid meat infusions and abscesses.

Habitat: Putrefying materials.

2. Proteus mirabilis Hauser. (Hauser, Sitzungsber, d. phys. mediz. Sozietät zu Erlangen, 1885, 156; Bacillus mirabilistrevisan, I generi e le specie delle Batteriacee, 1889, 17; Bacillus proteus mirabilis Kruse, ia Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 276; Bacterium mirabilis Chester, Del. Coll. Agr. Exp. Sta., 9th Ann. Rept., 1897, 101; Bacillus pseudoramosus Migula, Syst. d. Bakt., 2, 1900, 817; not Bacillus pseudoramosus Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1912, 441; Bacillus proteus-mirabilis Holland, Jour. Bact., 5, 1920, 220.) From Latin mirabilis, wonderful.

Short rods: 0.5 to 0.6 by 1.0 to 3.0 microns, occurring singly, in pairs and frequently in long chains. Motile, possessing perstrichous flagells. Gram-negative.

Gelatin colonies: Irregular, spreading. Gelatin stab: Slow, stratiform liquefaction

Agar colonies: Gray, irregular, spread-

ing.

Agar slant · Thin, bluish-gray, spread-

ing over surface.

Broth: Turbid, with thin gray pellicle and sediment.

Litmus milk: Slightly acid, becoming

alkaline, peptonized.
Potato: Dirty-gray, spreading growth.

Indole not formed.

Acetylmethylcarbinol frequently pro-

duced weakly.

Nitrites produced from nitrates.

Acid and gas from glucose, fructose and galactose. Acid and gas usually produced slowly from sucrose. No acid or gas from lactose, maltose, dextrin or mannitol. The XK strains are mostly maltose negative,

Putrefactive odor produced.

Hydrogen sulfide is produced. Sodium citrate usually utilized as a sole source of carbon.

Aerobic, facultative.

Optimum temperature 37°C.

Source: From putrid meat, infusions and abscesses. Also reported as a cause of gastroenteritis (Cherry and Barnes, Amer. Jour. Pub. Health, 39, 1946, 45th.

Habitat: Putrefying materials.

3. Proteus morganii (Winslow et al.) Rauss. (Organism No. 1, Morgan, Brit. Med. Jour., 1, 1906, 908: Bacillus morgani Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 481: Bacterium morgani Holland, Jour. Bact., 5, 1920, 215; Bacterium metacoli or Escherichia morgani Thjøtta, Jour. Inf. Dis., 45, 1928, 349; Salmonella morgani Castellani and Chalmers, Man. Trop. Med., 1919, 939; Rauss, Jour. Path. and Bact., 42, 1936, 183; Morganella morganii Fulton, Jour. Bact, 46, 1943, 81; regarded by Fulton as the type species of the genus Morganella) Named for Morgan, who first isolated this oreanism.

Common name: Morgan's bacillus, type 1.

Rods: 0.4 to 0.6 by 1.0 to 2.0 microns, occurring singly. Motile with pentichous flagella. See Rauss, loc. cit., for discussion of flagellation and relation to the swarming characteristic. Gramnecative.

Gelatin colonies: Bluish-gray, homogeneous, smooth, entire.

Gelatin stab: No liquefaction.

Agar colonies: Grayish or bluish-white, circular, entire.

Agar slant: Grayish-white, smooth, glistening growth.

Broth: Turbid.
Litmus milk: Neutral, or becoming alkaline.

Potato: Dirty-white, limited growth.

Indole is formed.

Nitrites are produced from nitrates. Acetylmethylcarbinol not formed.

Acid and a small amount of gas from glucose, fructose, galactose and mannose Rarely from xylose. Does not attack lactose, sucrose, maltose, arabinose, raffinose, detrin, salicin, mannutol, dulcitol, sorbitol, adopatol or mostol,

Hydrogen sulfide not produced. Sodium citrate not utilized as sole

Sodium citrate not utilized as solsource of carbon.

Aerobic, facultative.

Optimum temperature 37°C

Source: Isolated from the feces of infants with summer diarrhea.

Habitat: In intestinal canal is normal or dearrheal stools.

4. Proteus rettgeri (Hadley et al ) Rustigian and Stuart. (Bacterium rettgers Hadley, Elkins and Caldwell, Rhode Island Agr. Exp. Sta. Bull 174, 1918, 169, Bacıllus rettgeri St. John-Brooks and Rhodes, Jour. Path, and Bact , 26, 1923, 431; Eberthella rettgeri Bergey et al , Manual, 1st ed., 1923, 232; Shigella rettger: Weldin, Iowa State College Jour Sci , 1, 1927, 181; Atypical enteric organisms of the Shizella group, Cope and Kilander, Amer Jour Pub Health, 52, 1942, 352; Proteus entericus Rustigian and Stuart, Jour Bact . 45, 1943, 198; Rustigian and Stuart, Proc Soc Exp. Biol. and Med., 53, 1943, 241 ) Named for L. F. Rettger, the American bacterrologist, who isolated this species in 1904.

Rods: 0 5 to 0 8 micron long, occurring singly, in pairs and occasionally in chains. Usually non-motile at 37°C, but actively motile variants possessing peritrichous flagella can be obtained at 25°C. Gramnegative.

Gelatin colonies: Small, grayish, translucent, entire.

Gelatin stab: No liquefaction.

Agar colonies: Small, grayish, translucent, entire; under suitable conditions some strains show marked spreading. Agar slant: Filiform to echinulate, grayish, thin, moist, translucent. Broth: Turbid with flocculent to

viscid sediment. Litmus milk: Alkaline in eight days,

becoming translucent.

Potato: Luxuriant, grayish growth.

Acid and occasionally slight gas from glucose, fructose, galactose and mannitol. Salicin may or may not be fermented. Slow and sometimes weak acid in sucrose. Lactose and maltose not fermented.

Indole is formed.

Nitrites are produced from nitrates. Acetylmethylcarbinol not formed. Hydrogen sulfide not produced.

Sodium citrate utilized as sole source of carbon.

Aerobic, facultative.

Optimum temperature 37°C.

Source: Originally isolated from cholera-like epidemic among chickens; recently isolated from sporadic and epidemic castroenteritis nationts.

Habitat: Fowl typhoid and some cholera-like diseases of birds.

Appendix: Acceptance of gelatin liquefaction and fermentation of glucose and sucrose but not lactose as the cardinal characteristics of Proteus without reference to urease production and small gas volumes has resulted in some cultures of Paracolobactrum (Borman et al., Jour Bact., 48, 1944, 361) being described as Proteus (Rustigian and Stuart, Jour. Bact , 49, 1915, 419) Included in the appendix are species of Proteus whose taxonomic position is not clear. Where descriptions permit, the probable taxonomic position of the organism is indicated. For purposes of reference, orcanisms are also included which do not now ment species rank in the genus Protess and preamants which will now be found in another genus.

Bacillus agglomerans Beijerinck. (Botan. Zeitung, 46, 1888, 740 or 749.) From nodules on the roots of red clover. Colonies like those of Proteus. Bacillus murisepticus pleomorphus Karlinski. (Karlinski, Cent. f. Bakt., 5, 1889, 193; Proteus of Karlinski, Sternberg, Man. of Bact., 1893, 460) From a urine discharge and from absecsses in the uterus. Sternberg regards this species as probably identical with Proteus vuldars Hauser.

Flavobacterum mennqiitdis Hauduroy et al. (Bacillus luteus luquefacines Hauduroy, Duhamel, Ehringer and Mondin, Compt. rend Soc. Bod., Paris, 110, 1932, 362; Hauduroy et al., Dict. d. Bact. Path., 1937, 236) Related to this species but differing in that it ferments lactose is the following. Bacterum coli var. luteoliquefaciens Lehmann and Levy, in Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 34! (Bacillus coli var. luteoliquefaciens Hauduroy, Duhamel, Ehringer and Mondin, loc. cit., 1932, 363).

Proteus alvercola Serbinow. (Jour. Microbiol., Petrograd, 2, 1915, 19.) From an infectious diarrhoea of honey bees (Apis mellifera).

Protess americanus Pacheco. (Sciencia Medica, 6, 1923.) From the blood of patients with liver abscesses Assis (Brasi) Medico, No. 42-45, 1934, 35), St. John-Brooks and Rhodes (3rd Internat. Cong. for Microbiology, Rept. of Proc., 1939, 167), Rustigan and Stuart (Jour. Bact., 45, 1944, 123) agree that Protess americanus is Protess americanus is Protess mirabilis. See Manual, 5th ed., 1939, 434 for a description of this species.

Proteus ammoniae Magath, (Magath, Jour Inf. Dis., 48, 1928, 181; Salmonella ammoniae Hager and Magath, Jour. Amer. Med Assn., 85, 1925, 1352.) From urne in cystitis. St. John-Brooks and Rhodes (36, 41 Internat. Congr. for Microbiology, Rept of Proc., 1939, 167), Levine (Jour. Bact., 48, 1942, 33), Rustigan and Stuart (Jour Bact., 45, 1943, 195) and Thornton (Jour. Bact., 48, 1944, 123) agree that Proteus ammoniae is Proteus ammoniae is Proteus ammoniae is Proteus ammoniae is See Manual, 5th ed., 1939,

434 for a description of this species. See Fulton, Jour. Bact., 51, 1946, 685 for the view that *Proteus ammoniae* is a valid species.

Profess bombyeis Bergey et al. (A Gram-negative bacillus, Glaser, Jour. Bact., 9, 1924, 344; Bacterium bombytivorum Lehmann and Neumann, Batt. Diag., 7 Aufi., 2, 1927, 445; Aerobacte bombycis Bergey et al., Manual, 4thed., 1934, 365.) From diseased silk worms (Bombyz mori). Profess bombycis spears to be a strain of Paracolobactum aerogenoides Borman et al. See Manual, 5th cd., 1939, 436 for a description of this species.

Proteus diffuens (Castellani) Castellani and Chalmers. (Bacillus diffuent Castellani, 1915; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 913.) From gastroenteritis patients This may be a biochemical variant of Proteus mirabilis.

Proteus henricensis Shaw. (Sci., 65, 1927, 477.) From putrefying materials Said to be related to Proteus diffuens

Proteus infantum (Weldin and Levius)
Weldin. (Dean, Med. Jour. Australis,
1, 1920, 27; Bacterium infantum Weldin
and Levine, Abst. Bact., 7, 1923, 13;
Weldin, Iowa State Coll. Jour. Sci., 1,
1926, 148.) From urine and feccs of an
infant.

Proteus insecticolens Steinhaus. (Jour. Bact., 42, 1941, 763.) From the stomach of the milkweed bug (Oncopellus fasciatus). This appears to be a strain of Paracolobactrum intermedium Borman et al.

Proteus melanorogenes Miles and Halnan. (Jour. Hyg., 57, 1937, 79) From eggs showing black rot. This does not appear to be a member of the genus Proteus.

Proteus metadifficens (Castellani) Castellani and Chalmers. (Bacillus metadiffuens Castellani, 1915; Castellani and Chalmers, Manual Trop. Med., 1919, 943.) From gastroenteritis ratients This does not appear to be a member of the genus Proteus

Proteus nadsonn Lobik. (Discases of Plants, St. Petersburg, 9, 1915, 67.) From decomposed potatoes and tomatoes. This does not appear to be a member of the genus Proteus

Proteus noctuarum (White) Bergey et al (Bacillus noctuarum White, Jour Agr. Res. 26, 1923, 488; Eccherchia noctuari Bergey et al., Manual, 3rd ed., 1930, 327; Bergey et al., Manual, and ed., 1934, 363.) A cause of cutworm (Fam Noctuade) septicema Culturally identical with but serologically different from Proteus sphingulus

Proteus odorans Pribram. (Bacterium aquatile odorans von Rigler, Hyg. Rund, 12, 1902, 479; Pribram, Klassifikation der Schizomyceten, Leipzig and Wien, 1933, 73) From bottled mineral waters Aromatic odor in milk.

Proteus paraamericanus Magalh\u00e4es and Arag\u00e3o (Brasil Medico, 47, 1933, 815) From urine. Assis (Brasil Medico, No 42-45, 1931, 35) states that this is Proteus murabilis.

Proteus paradifluens (Castellanı) Castellani and Chalmers. (Bactilus paradifluens Castellanı; Castellanı and Chalmers, Manual Trop Med., 3rd ed., 1919, 913) This appears to be identical with Proteus mirabilis

Proteus paramorganii Castellani and Chalmers (Man. Trop Med., 3rd ed., 1919, 913.) This is an H form of Proteus morganii

Proteus photuris Brown (Amer Museum Nov, No. 251, 1927, 9) From lumnous organ of the firefly (Photuris pennsylfanicus). This does not appear to be a member of the genus Proteus.

Proteus pitciedus rersicolor Rabes and Biegler (Babes and Biegler, Cent. f Bakt., I Abt., Ong., 53, 1902-03, 449, Bacillus pisciedus rersicolor Nepveux, Thèse, Fac. Pharm., Paris, 1920, 114) From diseased carp (Cyprinis carpio) Resembles Proteus vulgaris

Proteus pseudoraleries Assis (Jour.

Hyg., 27, 1927, 1983.) Rustigan and Stuart (Proc. Soc. Exper Biol. and Med., 53, 1943, 211) state that this is a paracolon organism, presumably Paracolobactrum coliforme Borman et al. See Manual, 5th ed., 1939, 435 for a description of this species

Proteus recticolens Steinhaus. (Jour. Bact , 42, 1941, 763) From pi lorus and rectum of the milkweed bug (Oncopellus fasciatus). This appears to be a strain of Paracolobactrum intermedium Borman et al.

Proteus sphingulis (White) Bergey et al. (Bocillus sphingulis White, Jour. Agr Res, 20, 1923, 40; Escherichia sphingulis Bergey et al., Manual, 3rd cd., 1930, 327, Bergey et al., Manual, 4rd ed., 1931, 366) A cause of hornworm septicemus (Protoparce sexta Johan, and P quinquemoculata Haw.). See Manual, 5th ed., 1939, 605 for a description of this species White (loc. ct.) regards this species as possibly identical with Coccolcullus arridorum d'literelle.

with Coccobacillus aeridorum d'Herelle.
Proteus sulfureus Holschenikoff.
(Holschenikoff. (Holschenikoff.
(Holschenikoff. 1889, 201 and Ann de Mierogr., I, 1889, 289), 257; Bezillus lindenborut Trevisan, I generi e le specie delle Batteriacee, 1889, 17; Bazillus sulfureus Migula, Syst d Bakt, 2, 1900, 608; not Bazillus sulfureus Trevisan, I generi e le specie delle Batteriacee, 1889, 17) From water. Similar to or perhaps identical with Proteus eulgrais Hauser. Produces II,8

Proteus sp Steinhaus. (Jour. Bact., 42, 1941, 764) This organism appears to be a strain of Paracolobactrum intermedium Borman et al.

Proteus sp Warren and Lamb. (Jour. Med. Res., 44, 1924, 375) From feces and blood of patient with a fatal infection. This organism does not appear to be a member of the genus Proteus.

Urobacillus hquefaciens septicus Krogius. (Compt. rend Soc Biol., Paris, 2, 1890, 65.) Regarded by Lehmann and Neumann (Bakt Ding., 1 Aufl., 2, 1896, 213) as a synonym of Proteus sulgaris. The nomenclature used in the present edition of the Manual is slightly modified from that used in the fifth edition. The form adopted is in accordance with the view that the recognition of similar antigenic structures really identifies scrotypes rather than species. In a way, scrotypes are varieties in a taxonomic sense, though hke horticultural varieties in higher plants, they do not exactly correspond with varieties as usually defined by taxonomists. Where cultural differences rather than antigaic structure have been used to subdivide species, these subdivisions are designated as varieties.

As it is not clear as yet how many and what species will eventually be recognized, the form Salmonella sp. has been used as before to indicate that the serotypes belong to species in the genus Salmonella which are not yet definitely defined. Geographic and other proper names are used to designate types as these have been used extensively in the literature. They have an historic significance and are not as easily confused as are letters and numbers. No Latin endings have been used for these place names as this might indicate that the scrotype names are accepted as species names.

The genus Eberthella has been combined with the genus Salmonella as recommended by Schutze et al. (loc. cit.). With the exception of the typhoid organism, other species previously listed in Eberthella appear not to exist in type culture collections As cultures are not available for study, these species are merely listed in an appendix to the genus Salmonella.

The type species is Salmonella choleraesuis (Smith) Weldin.

The table on pages 495 to 500 is used in place of the usual key.

Serulogical Types in the Genus Salmonella. Intigenie Structure

1	1 3	T. Care	Sematic (O) Autocox	Hagetlac (1	Flagellac (H) Aptigens	
d pour	?	1164	and the last state of the last	Phase 1	Phase 2	
<	-	Salmouella paratyphs	(f), ft, X1I	ų	ł	
	**	Salmotte lla schottmuellers	III, IV, (VI, XII	q	11, 23	
	~	Schwardt an (Tynn Monv)	GI. IV. V. XII	-	×	
	-	Samonella tunhimurum	Ξ		. 2.3	
	-	Salmenella sp. (Type Kala)	2	. >	1, 2, 3	,
	9	Salmonella sp (Type Stanley)	IV. V. XII	. 🗢	1,2	г,л,
	ł ==		IV, V, XII	4	1, 2, 3	MIII
	œ	Salmonella sp (Type Chester)	IV, [V], XII	e, n	e, n, x	73.
	•		IV, [V], MI	o, h	e, n, z <sub>is</sub>	E
	2		11, NI	d, e, b	d, e, n, z <sub>18</sub>	× 1.
	=	Salmonella sp (Type Saint Paul)	I, IV, V, XII	e, h	1, 2, 3	E/10
	118	(Salmonella sp (Type Zygreb))	IV, V, XII	6,3	1.3	U
	ဌ	Salmonella sp (Type Reading)	IV, XII	r, 2	1.5	sa.
	ន្ទ	(Salmonella sp (Type Kaposvar))	IV, V, XII	e, (h)	1.5	311
	=		IV, XII	6, h	1,7	LIC.
=	**	_	(II, IV, XII	10	. 1	LAC
	2 :			E, E	ţ	i Est
	9 !			+ 10	1	LE
	2 2	Salmoneila sp (T) pe California)	IV, XII	5, m, t	1	
	9 5	catmonetta sp. (1ypo Brandenburg)		۱, ۷	6, 13, 211	
	3 5	Sammer of (1) The Maperierg)		<b>e</b>	e, n, x	
	: =	Salmonesta degratioequina		1	6, 11, 4	
	3 5	Salmonella op (17pc Areenavaleta)	Ĕ	ಜ	1,7	
	3 5	Calamara apprinted to		v	7,0	
	? ?	Salmontila sp. (15 pe Altendorf)		b	1,7	
	7	Saimoneila ep. (Lypo Texas)	IV, V, XII	<b>.</b> ×	e, n, z <sub>is</sub>	4
=	eignifie	l leignifies that this antigen may be absent. () signifies that	( ) signifies that only a part of this antigen is present.	resent.		195

Serological Types in the Genus Sa'monella-Antigenic Structure-Continued.

																					0	-1					
	Flagellar (II) Antigens	Phase 2	e, n, x	1,7	!	1,7	u -	, r	2 12	) i	· 1	ì	1.9.3	1			0, 11, 21,	1, 5	c, n, x	e, n, z <sub>15</sub>	1	1, 2, 3	1, 5	e, n, z <sub>18</sub>	0, n, z <sub>11</sub>	1, 10	
communica.	Flagellar	Phase 1	д	l, v	b, z <sub>13</sub>	e	0	[0]	<u>[0</u>	K.	g, m, s	m, t	-	et	P	е, Ъ	I, v	'n	'n	'n	£z.	۸, ۱	4 .4		٠ >		_
The court	Somatic (O) Antigens		[I], IV, XXVII, XII	IX YXXIII, XII	XXVII,		VI, VII, [Vi]	VI, VII	VI, VIII	VI, VII	V1, VII	V1, VII	V1, VII	V1, VII	V1, VII	V.1, V.11	V. 1, V.11	VI VII	VI. VII	VI. VII	VI, VII	VI, VII	VI, VII	VI, VII	V1, VII	vi; vii	
	Billian	Salmonella obartuska	Salmonella sp. (Type Bredeney)	Salmoncila sp. (Type Schleissheim)	Saimonetta sp. (Type Schwarzengrund)	Salmonella hirseb Coldis	Salmonella choleracsuis	Salmanella typhisus	Salmonella sp. (Type Thompson)	Salmonella sp. (Type Montevideo)	Salmonella sp. (Type Oranienburg)	Salmonella sp. (Type Virchow)	Salmonella sp. (Type Oslo)	Salmonella sp. (Type Amersfoort)	Salmonella sp. (Type Braenderun)	Salmonella sp. (Type Potsdam)	Salmoncila sp. (Type Barelly)	Solmonella sp. (Type Hartford)	Salmonella ap. (Type Mikawasima)	Salmonella an (T. C. Lanessee)	Salmonella sp. (Type Concord)	Salmonella sp. (Type George)	Salmonella sp. (Type Papus)	Salmonella sp. (Type Richmond)	Salmonella ap. (Type Cardiff)	. (13pe Daytona)	
_	Š.	13	50	2 6	3	ន	8	31	, E	33	#		8 8	÷ 6	3 8	3 5	<b>?</b>	: 5	43	#	45	÷	- 42	şę	8		
	Group		4							_			c	5													

	5	-	VI, VIII	[e, h]	1,2,3
	3		777 474		1 10
	Ħ	Salmoncila sp. (Type Kottbus)	V1, V111	- - -	
	5	Salmonella sp. (Type Muenchen)	, , , , , , , , , , , , , , , , , , ,	<b>3</b> ~	
ű	548		V1, V111	<b>3</b> -	· ·
	13	Salmonella ep (Type Manhattan)	VI, VIII	₽,	3,0
	8	Salmonella sp. (Type Litchsfeld)	VI, VIII	١, ٧	1, 2, 3
	lā	Salmonella morbificans	VI, VIII		1,5
	3	Salmontilla an (Type Natashino)	VI, VIII	æ	c, n, x
	53		VI, VIII		e, n, x
	8	_	VI, VIII	210	e, n, z,s
	79		VI, VIII	24, 221	ŧ
	8		VI, VIII	24, 233	ı
	8		VI, VIII	p	e, n, x
	5	_	(VIII)	۱, ۷	1,6
	:3	_	(VIII)	ď	. 1
1	1				
	8	Salmonella tuphosa	IX, XII, [V <sub>1</sub> ],	P	t
	6	Salmonella enteritidis	[I], IX, XII	В, ш	ı
	æ	Salmonella 1p. (Type Dublin)	I, IX, XII	8, 12	ı
۵	S	Salmonella sp (Type Rostock)	1, IX, XII	n 'd '9	ı
	2		IX, XII	6, 0	1
	7	Salmonella sp (Type Blegdam) .	IX, XII	g, m, c	ı
	£5	_	1х, хп	f, g, t	ı
	E	Salmonella sp (Type Penancola)	IX, XII	g, m, t	ı
	=	Salmonella sp (Type Cluiborne)	1, IX, XII	×	1,5
	2	_	(I), IX, XII	8	1,5
	6		IX, XII	63	1,5
	1:	Salmonella sp. (Type Durban)	IX, XII	61	e. n. z.s
	85	Salmonella sp. (Type Onarimon)	1, 1X, XII	p	1,2
=	rignifi	[   signifies that this antigen may be absent. ( ) signifies tha	() signifies that only a part of this antigen is present	resent.	

Serological Types in the Genus Salmonella-Anligenic Structure-Continued.

															• • •			L	110	LU	uı				
	Flageliar (II) Antigens	Phase 2	1.5	1,5	e, n	e, n, z,s	.,	1	-	o	, ,	4 4 5 6 6	1,5,		1,6	7,7		, -	1, 2	1,2,3	l, w	1, 5	1,5	1,2,3	Z, 1, 0
anen.	Flageliar	Phase 1	e, b	1, v	I, w	, v	I, Z28	ı	1 4	<u> </u>		:	1, v		> ;	A	1, c	e 6	e, h	e, h	e, h	7	.44	, , ,	
transport of artists of the control	Somatic (O) Antigens		[1], IX, XII	t, IX, XII		17, XII	[1], 1A, A11 [1], 1X, X11	11X, XI	X,XII	IX, XII	[I], IX, XII	IX, XII	гх, хи	111 X XXVI	III. N. VXVI	III, X, XXVI	III, X, XXVI	III, X, XXVI	III, X, XXVI	III, X, XXVI	III, X, XXVI	III, X, XXVI	111 V VVVI	III, X, XXVI	III, X, XXVI
	Types			Solmonella sp (Type Panama)	Salmonella sp. (Type Dar-es-Salaam)	Salmonella sp. (Type Jaya)	Salmonella gallinarum	Salmonella pullorum	Salmonella sp (Type Canastel)	Salmonella sp. (Type Italia)	Salmonella sp. (Type Napoli)	Salmon II. (Type Long Linda)	Sumoneila sp. (1ype New York)	Salmonella sp. (Type London)	Salmonella sp. (Type Give)	Salmonella sp. (Type Uganda)	Salmonally and the	Salmonella sp. (Lype Muchster)	Salmonella sp. (Type INyborg)	Salmonella sp. (Type Meleamis)	Salmonella sp. (Type Shangani)	Salmonella sp. (Type Zanzibar)	Salmoncila sp. (Type Amager)	Salmonella an. (Type Lexington)	( in the control of t
	ģ	-	6 8	3 6	8 8	æ	<u>ت</u> ا	8	2 8	8 6	8 8	8 8	3	៩ខ	3 8	3 2	. 6	8	26	98	8	8	2 6	103	
	Group						Ω								£.	ជ									

	101	Salmonella sp (Type Onon)	111, X, XXV1	^	7, 3
	103	Salmonella en (Type Butantan)	111, X, XXVI	4	2,2
	202	Salmonella sp (Type Newington)	111, XV	a, a	1,6
ŭ	101		III, XV	e, h	1,7
	3	Salmonella sp. (Type New Brunswick)	III;XV	٠,٠	1,7
	ē	Salmonella sp (Type Illinois)	(III), (XV), XXXIV	2.01	1, 5
	1	Calmonalla on Three Sectionborns	ן זון גוג		
	3	Salmonella en (Typo Niloso)	111 717	,	2
ធ្បី	:		711 711	, 1	: 1
	1 2		1, III, XIX		92
	=	Solmonella an (Two Kentucky)	XX	-	2.0
	12	_			
	:	-			
	2 :	~ `		<u>.</u> .	κ'α',
		_		<u>~</u>	1, 2, 3
	138	_		-	e, n, x
	9	_		'n	
	2	~		=	o, n, z,
	2	Salmonella sp (Type Senegal)			1.5
p.	23	_		e	
	ន	_	XXII.	-	1.7
	Ē		XXII		
	23	$\overline{}$	1XX		
-	22	Salmonella Ip (Type Mississippi)	1. XXIII		
	23		L XXIII	-	· 1
	25		I. XXIII		í
_	ន្ទ	Salmonella sp (Type Worthungton)	I. XXIII	0 8	
	8	Salmonella sp (T) pe Cuba)	LXXIII		. 1
	13	Salmonella sp (Typo Heves)	· rv, xxrv	r o	1,5
=	aignifie	( laignifies that this antigen may be absent. ( ) eignifies tha	( ) eignifies that only a part of this antigen is present.	resent.	

Serological Types in the Genus Salmonella - Antigentic Structure - Concluded.

		Delivery 1 ples tit de Cenas Samioneria Armigentic del actua	a mingement on actual contra	the con-	
Group	2	Tyces	Somatic (O) Anatigens	Thagellar (f	Magellar (II) Antigens
				Phase 1	Phase 2
_	132	Salmonella sp (Type Carrau)	VI, XIV, XXIV	,	1,7
	133	Salmonella sp (Type Onderstepoort)	(I), VI, XIV, XXV	e, (ħ)	1,5
	134	Salmonella sp (Type Florida)	(I), VI, XIV, XXV	7	1,7
	135	Salmonella sp (Type Madelia)	(I), VI, XIV, XXV	'n	1,7
	136	Salmonella sp. (Type Sundsvall)	(I), VI, XIV, XXV	×	e, n, x
	137	Salmonella sp. (Type Orient)	XVI	4	c, n, z <sub>15</sub>
	138	Salmonella sp. (Type Hvittingfoss)	IAX	ą	e, n, x
	139	Salmonella sp. (Type Gaminara)	XVI	q	1,7
Œ	140	Salmonelia sp. (Type Scentes)	XYZ	24	1, 2, 3
	141	Salmonella sp. (Typo Kirkee)	. IIAX	q	1,2
	142	Salmanella sp. (Type Cerro)	. XVIII	Z4, Z21, Z21	1
	143	Salmonella sp. (Type Minnesota)	XXI, XXVI	q	6. n. x
	#	Salmonella sp. (Type Tel Aviv)	XXVIII	>	. n. z
	145	Salmonella sp (Type Pomona)	XXVIII	, >	1, 7
	146	Salmonella sp. (Type Ballerup)	XXIX, [Vi]	ziz	
	142	Salmonella sp. (Type Hormaeche)	XXXX, [VI]	Z30. [Zat]	ł
	118	Salmonerla sp. (Type Urbana)	XXX	, a	y
	149	Salmonella sp. (Type Adelaide)	XXXX	£. 2	:
	3	Salmonella sp. (Type Inverness)	XXXVIII	, <sub>14</sub>	1.6
	151	Salmonella sp. (Type Champaign) .	XXXXIX	-24	1, 5

() signifies that only a part of this antigen is present. I Isignifies that this antigen may be absent.

1. Salmonella paratyphi (Kayser) Castellani and Chalmers. (Bacterium paratunha Tunus A Brion and Kayser Minch med Websschr. 49 1902 611 Bacterium naratunki Kayser, Cent f. Bakt., I Aht., Ong., 31, 1902, 426; Bacillus paratunhosus A Boycott Jour Hyg. 6, 1906, 33; Bacillus naratunhi Winslow and Kligler, Jour. Bact. 1. 1916, 81. Bacillus paratuphasus Winslow. Kheler and Rothberg, Jour. Bact. 4 1919. 474: Salmonella paratuphi and Salmonella paratunha A Castellana and Chalmers Man Trop Med 3rd ed . 1919, 938 and 939, Bactersum paratyphosum A Holland, Jour Bact . 5, 1920. 219 ) From Latin para, like and tunhus typhoul.

Rods 0 6 by 3 0 to 4 0 microns, occurring singly. Motile with peritrichous flagella. Gram-negative

Gelatin colonies Bluish-gray, homogeneous, smooth, glistening, entire to shightly undulate

Gelatin stab , Fair surface growth No

Agar colonies. Grayish, homogeneous, smooth, glistening, entire to slightly

Agar slant. Filiform, grayish, smooth, glistening growth.

Broth Turbid, with slight grayish sediment.

Litmus milk: Slightly acid

undulate

Potato. Limited, dirty-white streak Indole not formed

Nitrites produced from nitrates
Acid and gas from glucose, fructose,

Acid and gas from glucose, fructose, galactose, mannose, arabinose, maltose, trehalose, dettrin, glycerol, manniol, dulcitol, rhamnose and sorbitol. No acid or gas from lactose, sucrose, raffinose, xylose, saliem, inulia, adonitol or mostiol

Reduces trimethylamine oxide (Wood and Baird, Jour Fish, Res. Bd Canada, 6, 1913, 198).

No hydrogen sulfide formed Aerobic, facultative. Optimum temperature 37°C. Antigenic structure: [I], II, XII.a; ..., (Type Durazzo lacks I).

Source: Isolated from enteric fever in man. Not known to be a natural pathogen of animals.

Habitat: A natural pathogen of man causing enteric fever.

2. Salmonella schottmuelleri (Winslow et al.) Bergev et al (Bacilli paratyphique, Achard and Bensaude Soc. Méd. des Hôp. de Paris, 18, 1896, 679; Bacillus paratuphi alcaligenes Schottmüller. Deutsche med Wchnschr. 32 1900. 511: Bacterium paratuphi Typus B. Brion and Kayser, Münch, med. Wehnschr 49 1902 611 Bacillus paratuphasus B Boycott, Jour. Hyr. 6, 1906. 33. Bacterium paratuphosum B Le Blave and Guerenheim, Manuel Pratique de Diag. Bact., 1914: Bacillus schottmullers Winslow, Kligler and Rothberg, Jour. Bact . 4. 1919. 479. Salmonella paratunki B Castellans and Chalmers, Man Tron. Med. 3rd ed. 1919, 939, Bacterium schottmüller: Holland, Jour Bact., 5. 1929, 222; included in Group IV of Hecht-Johansen, Copenhagen, 1923; Bergey et al . Manual, 1st ed., 1923, 213.) Named for Prof Schottmüller who isolated this organism in 1899.

Rods. 0 6 to 0 7 by 2 0 to 3 0 microns, occurring singly and in pairs Motile with peritrichous flagella. Gram-negative

Gelatin stab. No liquelaction.

Agar colonies Small, circular, bluishgray, transparent, homogeneous, entire to undulate.

Broth Turbid with thin gray pelicle and sediment. Fecal odor Litmus milk. Slightly acid, becoming

Litmus milk. Slightly arid, becoming

Potato Grayish-white, viscous

Indole not formed

Nitrites produced from nitrates
Acid and gas from glucose, fructose,

galactose, mannose, arabinose, xylose, maltose, dextrin, trebalose, glycerol, mannitol, dulcitol, sorbitol, rhamnose and inositol. No acid or gas from lactose, sucrose, inulin, salicin or adonitol and usually not from raffinose.

Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide produced.

Optimum temperature 37°C.

Aerobic, facultative.

Antigenic structure: [I], IV, [V], XII: b: [1,2]. . . . Some strains lack antigen V and some have I.

Source: Isolated from eases of enteric fever in man. Not a natural pathogen of animals.

Habitat: A natural pathogen of man causing enteric fever. Also found rarely in cattle, sheep, swinc, lower primates and chickens.

3. Salmonella sp. (Type Abony). (Salmonella abony Kauffmann, Acta Path. et Microbiol. Scand., 17, 1940, 1.)

Antigenic structure [I], IV, V, XII: b e.n. v.

Source: Isolated by Kaufimann from a mixed culture of Salmonella abortus boris sent to him by Dr. K. Rauss, Budapest. Later three additional cultures were received from Dr. Rauss Original culture from the feeces of a normal person.

Habitat: All cultures thus far recognized have been from human sources.

4. Salmonella typhimurium (Loeffler) Castellani and Chalmers. (Bacillus typhi murium Loeffler, Cent. f. Bakt, 11, 1822, 192; Bacterium typhi murium Chester, Ann Rept Del Col. Agr Exp. Sta., 9, 1897, 70; Bacillus murium Migula, Syst. d Bakt, 2, 1900, 761; Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 939; Bacillus typhi-nurium Holland, Jour. Bact., 5, 1920, 221; Bacterium typhi-murium Holland, if the Holland, if the state of the state

The following are regarded as synonyms of this organism. Salmonella

psittacosis Castellani and Chalmers (Man. Trop. Med , 3rd ed., 1919, 939, Bacillus psittacosis Nocard, Conseil d. Hyg. Publique et Salubrité du Dept du Seine, Séance, March 24, 1893; Bacterium psittacosis Le Blaye and Guggenheim, Manuel Pratique de Diagnostic · Bactériologique, 1914): Salmonella gertrycke Castellani and Chalmers (Man Trop. Med., 3rd ed., 1919, 939; Bacillus aertrucke De Nobele, Ann Soc Mél Gand., 72, 1898, 281; Bacillus paraaertrucke Castellani, Ann. di Med Nav e Colon., 11, 1914, 453; Bacterium aertrucke Weldin and Levine, Abst. Bact. 7, 1923, 13); Kaensche's Bacillus and Basenau's Racillus, Kaensche, Ztschr. f. Hyg., 22, 1896, 53; Bacillus pestiscaviae Wherry (Jour. Inf. Dis , 5, 1908, 519: Bacillus cholera-caviae Wherry, Pub. Health Repts., November, 1908, Pasturella pestis-caviae Holland, Jour. Baet., 5, 1920, 219); Bacillus paralyphosus B, Mutton type, Schutze, Lancet, 1, 1920, 93; Group VII of Hecht-Johansen, Copenhagen, 1923; Salmonella aerirycke Ibrahim and Schütze, Brit. Jour. Exp Path., 9, 1928, 353; Bacterium enterthins Breslau and Salmonella breslau of German literature; Mouse-typhoid of many Some strains are confused with Salmonella anatis because of their origin in ducklings, e.g., see Salmonella anatum var. aertrycke Olsen and Goetchins, Cornell Vet , 27, 1937, 354

Hauduroy et al. (Diet d. Bact. Path. Paris, 1937, 449) regard the following as synonyms of Salmonella entryck: Baculus breslaviensis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1889, 37, 66; B. entertidis breslaviensis Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 2, 1896, 66; B. entertidis breslaviense Berge, Deut. Horbrith Wehnsehr, 1956, 473, Salmonella meleogridus Rettger, Plastidge and Cameron, Jour. Int. Dis., 43, 1933, 279; Salmonella cettycle var. meleogridus Cameron and Rettger, Journele Bact., 27, 1934, 88.

See Edwards and Bruner, Kentucky

Agr. Exp. Sta. Bull. 400, 1940, 43-70, for a discussion of this species.

Rods: 0 5 by 1.0 to 1.5 microns, occurring singly Motile with peritrichous flagella. Gram-negative

Gelatin colonies: Small, circular, gray-

Gelatin stab: Flat surface growth.

Agar colonies: Small, circular, grayish,

Agar slant: Filiform, grayish, moist,

Broth: Turbid.

Litmus milk: Slightly acid, becoming

Potato: Grayish-white streak

Indole not formed.

Nitrites produced from nitrates.
Acid and cas from clucose, fructuse.

Actu and gas from gueese, fractose, galactose, arabinose, maltose, destrin, mannitol, sorbitol and inositol Acid from glycerol. No action on lactose, sucrose, raffinose, inulin, salicin or adonttol.

Reduces trimethylamine oxide (Wood and Barrd, loc. cit ).

Hydrogen sulfide produced

Optimum temperature 37°C.

Antigenic structure [1], IV, [V], XII:

1 1, 2, 3 . . . Source: Isolated during a mouse ty-

phoid epidemic in the Hygienic Institute of Greifswald, Germany,

Habitat: Causes food-poisoning in man A natural pathogen for all warmblooded animals. This type occurs more frequently than any other type not confined to a specific host. Also found in snakes by Hinshaw and McNeil (Amer. Jour. Vet. Res., 6, 1915, 251).

4a. Salvonella tuphirurium (Type Binns). (Bacillus paratypheus B Banns type, Sel ütze, Lancet, I, 1920, 93, Group VI of Hecht-Johnnen, Copenhagen, 1923; Typu-llinns, Kauffmann, Zh. f. d. grs. Hug., 25, 1931, 273; Salmonella typhirurium vat. Copenhagen, Kauffmann, Ztschr. f. Hyg., 116, 1934, 368; Salmonella typhi-murium var. Binns, Schütze et al. Jour. Hyg., 54, 1931, 339; Salmonella aertrycke var. Storrs, Edwards, Jour. Bact., 50, 1935, 471.)

Morphology and cultural characters indistinguishable from those of Salmonella typhimurium, except some strains ferment maltose late or are anarrogenic.

Antigenic structure: [IJ, IV, XII: i-1, 2, 3 . . (Edwards, Jour. Hyg, 36, 1936, 348) Many colonies may be examined before the specific phase flagellar antigen is demonstrated. Differs from Salmonella typhimurum in lacking antigran V.

Source: Isolated by Dr. McNee from a case of food poisoning in man, France,

Habitat: Natural host the pigeon, and may infect other animals, including man.

Salmonella sp. (Type Köln). (Salmonella 151n Sievers, Cent. f. Bakt., I Abt., Orig., 150, 1943, 52; Salmonella coela Kaufimann, Acta Path. et Microbiol. Scand, Suppl. 51, 1914, 33)

Antigenic structure: IV, V, XII: y:

Source: A single culture isolated from a human case of enteritis.

Habitat, Not reported from other sources as yet.

6. Salmonella sp. (Type Stanley). (Bacillus paralyphosus B, Stanley type, Sci lutte, Lancet, 1, 1920, 33; Salmonella stanley Haupt, Ergebnisse d. Hyg, 13, 1932, 673, Salmonella Stanley type, White, Med. Res. Council, Spec. Rept. Ser. 103, 1920, 19; Salmonella stanley Warren and Scott, Jour. Hyg, 12, 1929, 415; Typus Stanley, Kaufimann, Ztschr. Hyg, 111, 1930, 210)

Antigenie structure: IV, V, XII: d:

Source: Isolated from cases of human food poisoning in Stanley, England by Hutchens (1917).

Habitat: Not known as a natural pathogen of animals.

7. Salmonella sp. (Type Heidelberg). (Bacterium enteritidis, Typus Heidelberg, Habs, Cent. f. Bakt., I Abt., Orig., 150, 1933, 367; Salmonella heidelberg Schutze et al., Jour. Hyg., 34, 1934, 340.)

Antigenic structure: IV, V, XII: r:

1, 2, 3 . . . Source. Isolated from cases of human food poisoning in Heidelberg, Germany.

Habitat: Not known as a natural nathogen of animals

8. Salmonella sp. (Type Chester). (Salmonella chester Kauffmann and Tesdal, Ztschr. f. Hyg., 120, 1937, 168.)

Antigenic structure: IV. [V]. XII: e.

h: e, n, x . . .

Source. Isolated by W. H. Grace, Chester, England, from gastroenteritis in man. Typed by Kauffmann and Tesdal (loc. cit.).

Habitat: Has usually been found in human feces.

9. Salmonella sp. (Type San Diego). (Salmonella san diego Kauffmann, Acta Path. et Microbiol Scand . 17, 1940, 429 ) Antigenic structure. IV, [V], XII: e,

he.n.zis ..

Source: Originally isolated from cultures sent to Dr. Kauffmann by Dr. K. F. Meyer who obtained them from an outbreak of food poisoning near San Diego, California Also reported from Den-· mark, Uruguay and Kentucky,

Habitat Usually has been isolated from human feces, but has been found in birds and other animals.

10 Salmonella sp. (Type Salmas). (Salmonella salinatis Edwards and Bruner, Jour Bact , 44, 1942, 289.)

Antigenic structure: IV, XII: d, e, h: d, e, n, z<sub>15</sub> . .

By cultivation in semi-solid agar con-

taining agglutinating serum for Sal-

monella typhosa, an organism having the antigenic formula for Salmonella sp (Type San Diego) was isolated

Source: From rat feces collected by Dr. Henry Welch near Salinas, California.

Habitat: Also found in normal human carriers.

 Salmonella sp. (Type Saint Paul). (Salmonella saint paul Edwards and Bruner, Jour. Inf. Dis., 66, 1940, 220)

Antigenic structure: I, IV, V, XII:e, h: 1. 2. 3 . . .

Source: A single culture isolated from the liver of a turkey poult by Dr. B. S. Pomerov, St. Paul, Minnesota. Two cases in man.

Habitat: Also reported from hogs

 Salmonella sp. (Type Zagreb) (Salmonella 2agreb Kauffmann, Acta Path. et Microbiol. Scand., 17, 1940, 351.)

Antigenic structure: IV, V, XII. e, h. 1, 2 . . . This is a minor type of No 11. Source: Culture received by Dr. Kauffmann under the label S. reading from Dr. N. Cernozubov of Zagreb,

Jugoslavia. Habitat: Not reported from other sources as yet.

Salmonella sp. (Type Reading) (Bacillus paratyphosus B, Reading type,

Salmonella readingensis Haupt, Ergebnisse d. Hyg., 13, 1932, 673.)

Antigenic structure: IV, XII: c, h:

Source: Isolated from the Reading, To along mater supply by Dr H Schütze.

Habitat: A cause of gastroenternis in man.

12a. Salmonella sp. (Type Kaposvar). (Salmonella kapostar Rauss, Cent f Bakt., I Abt., Orig, 147, 1941, 253; also see Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 212)

Antigenic structure: IV, V, XII: e, (h) 1, 5.... This is a minor type of No 12.

Source: From the feets of three mem-

bers of a family suffering from gastroenteritis.

Habitat: Not reported from other sources as yet.

13 Salmonella sp. (Type Kaapstad). (Salmonella reading var. kaapstad Henning, Rhodes and Gordon-Johnstone, Onderatepoort Jour. Vet. Sei. Animal Ind , 16, 1941, 103, Salmonella kaapstad Kaufimann, Acta Path. et Microbiol Scand., 19, 1942, 523.)

Antigenic structure: IV, XII. e, h.

Source, From a child with meningitis, Habitat: Not known from other sources as yet

14 Salmonella sp. (Type Derby) (Bacillus entertidis Peckham, Jour. 1195, 22, 1923, 69, Derby type, Savage and White, Med Res Council Spec Rept Ser. 91, 1925, 19; Salmonella derby War-

Antigenic structure [I], IV, XII:

Source. Isolated from tank water at Derby, England

Habitat. Widely distributed. Found in human feces, lymph glands of hogs, chickens, etc.

15 Salmonella sp. (Type Essen) (Salmonella essen 173 Hohn and Herrmann, Cent. f. Bakt., I Abt., Ong., 135, 1936, 255)

Antigenic structure: IV, XII:g, m -.

Source: Isolated from the feces of an infant, Essen, Germany,

Habitat, Known only from human sources.

 Salmonella sp. (Type Budapest).
 (Salmonella budapest Rauss, Ztschr. f. Immunitätel., 95, 1929, 489.)

Antigenic structure: I, IV, XII: g,

Source: Originally isolated in Budapest from 3 normal persons and from 3 persons with enteric fever.

Habitat: Known only from human sources

Salmonella sp. (Type California).
 (Salmonella california Edwards, Bruner and Hinshaw, Jour. Inf Dis., 66, 1940, 127; Hinshaw, Hilgardia, 13, 1941, 583.)
 Antigenie structure: IV, XII, g, m,

Antigenic structure' IV, AII, g, n

Source. Six cultures isolated from infected turkey poults from Cahfornia. The seventh culture was isolated from a turkey in a second outbreak of the infection Reported by Pomeroy and Fenstermacher (Jour. Amer. Vet. Med. Assoc. 94, 1936, 90). Miso found in hogs and min (Cubards and Bruner, Jour. Inf Dis. 72, 1913, 64).

Habitat, Also reported from chickens and ducks. Widely distributed

18. Salmonella sp. (Type Branden-burg). (Typus-Brandenburg, Kauff-mann and Matsus, Zischr. f. Hyg., 111, 1930, 740, Kauffmann, Zentbl. f. d ges Hyg., 25, 1931, 273, Salmonella brandenburgensus Haupt, Ergebnise d Hyg., 15, 1972, 673, Salmonella brandenburgensus Haupt, Ergebnise d Hyg., 15, 1972, 673, Salmonella brandenburg Schütze et al., Jour. Hyg., 34, 1931, 540). Anturence structure: IV, XIII. J., v.

e, n, z<sub>11</sub>... See Kauffmann, Ztschr. f. Hyg., 118, 1936, 510.

Source, Isolated from a case of gastroenteritis at the Virchow Hospital of Berlin. Habitat: Known only from human sources.

Salmonella sp. (Type Bispebjerg).
 (Salmonella bispebjerg Typus, Kauffmann, Ztschr. f. Hyg., 118, 1936, 540.)

Antigenic structure: 1, IV, XII: a: e, n, x. . . .

Source: Isolated from a case of gastroenteritis at the Bispebjerg Hospital in Copenhagen.

Habitat: Not reported from other sources as yet.

20. Salmonella abortivoequina (Good and Corbett) Bergey et al. (Bacillus aborticus equinus Good and Corbett, Jour. Inf. Dis., 18, 1913, 53; Bacillus abortus equi Meyer and Boerner, Jour. Med. Res., 29, 1913, 330; Bacillus abortivo-equinus Good and Corbett, Jour. Inf. Dis., 18, 1916, 586; Bacıllus abortus equinus Weiss and Rice, Jour. Med. Res., \$5, 1907, 403; Bacillus abortivus Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 177; Bacıllus abortus-equi Holland, Jour. Bact., 5, 1929, 216; Bacterium abortum-equi Holland, ibid.; Bergey et al , Manual, 1st ed., 1923, 217; Bacillus enteritidis B, Typ equinus Januschke, Ztschr. f. Infektionskr. d. Haustiere, 29, 1924, 182, Salmonella abortus-eque Bergey et al., Manual, 2nd ed., 1925, 236.) From Latin, aborting and equine.

Antigenic structure. IV, XII. -: e, n. x. . .

Reduces trimethylamine oude (Wood and Baird, loc. cit.).

Source: Isolated from afterbirth of mares that had aborted

Habitat. A natural pathogen of mares, causing abortion. Infectious for guinea pigs, rabbits, goats, cows, producing abortion

 Salmonella sp. (Type Arechavaleta). (Salmonella arechavaleta Hormaeche and Peluffo, quoted from Hormaeche et al., Jour. Bact., 47, 1944, 323) Named in honor of Prof. Arechavaleta of Uruguay.

Antigenic structure: IV, [V], XII: 8: 1, 7. . . .

Source: From a human case of gastroenteritis. Also found by Dr. P. R. Edwards among cultures sent to him from the Canal Zone for identification

Habitat: Known only from human

22. Salmonella abortusovis (Lovell) Schütze et al. (Becillus paratyph abortus ovis Schermer and Erhich, Cent. f. Bakk., I Abt., Ref., 73, 1922, 232, Becillus enteritidis C, Typ. ovis Januschke, Ztsch. I. Infektionskr. d. Haustiere, T, 1924, 182: Bacterium abortus ovis Lovell, Jour. Path. and Bact., 54, 1931, 43, Typus-Abortus ovis, Kauffmann, Zeulbl. f. d. ges. Hyg., 25, 1931, 273, Schütz et al., Jour. Hyg., 54, 1934, 430.)

Antigenic structure: IV, XII: c: 1,

6. . . . Reduces trimethylamine oxide (Wood

and Baird, loc. cil.).
Source: Isolated from cases of abortion

in sheep.

Habitat: Not known to infect any
other animal.

Salmonella sp. (Type Altendorf).
 Salmonella allendorf Hohn, Cent. f. Bakt., I Abt., Orig , 146, 1940, 218.
 Antigenic structure: IV, XII: c; 1.

7....

Source: Isolated from a case of scute gastroenteritis from Altendori, Germany.

Habitat: Not reported from other sources as yet.

24 Salmonella sp. (Type Tevas) (Salmonella texas Watt, De Capito and Moran, U. S. Public Health Repts., 62,

1917, 808.) Antigenic structure: IV, V, XII: k: e,

n, z<sub>1</sub>.... Source: Isolated by Dr. James Watt from the feces of a boy convalescing from diarrhoca. Habitat Not reported from other sources as yet.

25. Salmonella abortusbovis Kauffmann. (Kauffmann, Ztschr. f. Hyg., 120, 1937, 194)

Antigenic structure: [I], IV, XXVII,

Liquefics gelatin (Kauffmann, Ztschr. f Hyg., 117, 1936, 778).

Source: Isolated and incompletely typed by H Bernard, Ztschr. f. Hyg., 117, 1935, 352.

Habitat: Normally found in cattle, causing abortion Occasionally occurs in man.

26 Salmonella sp. (Type Bredeney) (Salmonella bredeney Kauffmann, Ztschr f. Hyg., 119, 1937, 356.)

Antigenic structure, I, IV, [XXVII],

Source: Found by Hohn and Herrmann in Bredeney, Germany. Typed by Kauffmann (loc cit.). From cases of human gastroenteritis and an abscess of lower jaw.

Habitat · Isolated from human sources Also found in normal hogs and chickens 27 Salmonella sp. (Type Schleiss-

heim). (Salmonella schleissheim Kauffmann and Tesdal, Zischr. f. Hyg., 129, 1937, 171)

Antigenic structure IV, XXVII, XII b, z<sub>11</sub> -.

Liquefics gelatin (Kauffmann and Tesdal, loc cit ).

Source Isolated by Hopfengärtner (Münchener tuerärz, Welnschr., 1, 1929, 185) in Schleisheim. From cattle Typed by Kauffmann and Tesdal (loc. art) Also found by Tillmanns in the liver of a horse (Ztachr. f. Fleisch, u Milch Ilyg., 80, 1910, 107). Caused an outbreak of gestroenteritis in 30 persons (Kauffmann, Acta Path. et Microbiol Scand., 17, 1910, 1).

Habitat: Apparently widely distributed.

29. Salmonella sp. (Type Schwarzen-

grund), (Salmonella schwarzengrund Kauffmann, Acta Path. et Microbiol. Scand. Suppl. 44, 1944, 24.)

Antigenic structure: I, IV, XXVII, XII: d: 1.7.

Source: A single culture isolated by Dr. J. Hohn from a human case of enteritis that occurred in Schwarzengrund, near Breslau. Germany.

Habitat: Not reported from other

29. Salmonella hirschfeldii Weldin. (Bacillus paratyphosus & Weil, Wien, Llin, Wehnschr., 30, 1917, 1061: Bacillus erzinian Neukirch, Zischr. f. Hyg. 85. 1918, 103; Paratyphoid C bacillus, Hirschfeld, Lancet, 1, 1919, 296; "Para-C". Mackie and Bowen, Jour. Rov. Army Med. Corps, \$3, 1919, 154: Bacillus paratuphosus C Andrewes and Neave. Brit. Jour. Exp. Path., 2, 1921, 157; Paratyphus N. Iwaschenzoff, Arch. f. Schiffs-u, Trop. Hvg . 30, 1926, 1; Weldin. Iowa Sta. Coll. Jour. Sci., 1, 1927, 161; Bacterium hirschfeldig Weldin, ibid., 161; Typus-Orient, Kauffmann, Zbl. f. d. ges Hyg. 25, 1931, 273; Salmonella paratuphi C Castellani and Chalmers. Man. Trop. Med., 3rd ed., 1919, 939; Salmonella paratyphosus C Castellani and Chalmers, 1bid., 952.) Named for Hirschfeld who worked with this

Rods: 0.3 to 0.5 by 1.0 to 2.5 microns, occurring singly. Motile with peritrichous flagella. Gram-negative.

Gelatin colonies: Grayish, smooth, flat, glistening, margin irregular.

Gelatin stab: Flat, grayish surface growth, No liquefaction.

Agar colonies: Grayish, moist, smooth, translucent

Broth: Turbid.

organism

Litmus milk: Slightly acid, becoming alkaline.

Indole not formed

Nitrites produced from nitrates.
Acid and gas from glucose, fructose.

Acid and gas from glucose, fructose, maltose, arabinose, xylose, dextrin, trehalose, mannitol, dulcitol and sorbitol. No action on factore, sucrose, salicin, adonitol or inositol. Rarely may fail to form gas from sugars (Nabih, Jour. Hyg., 41, 1941, 39).

Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide produced.

Optimum temperature 37°C.

Aerobic, facultative.

Antigenic structure: VI, VII, [Vi]: c:1,5....

Source: Isolated from cases of enteric fever in man.

Habitat; A natural pathogen of man causing enteric fever.

30. Salmonella choleraesuis (Smith) Weldin. (Probably not the Bacillus of swine plague, Klein, Report of the Medical Officer of the Local Gov. Bd., England, 1877-78, Supplement, p. 168; Bacterium of swine plague, Salmon, U. S. Dept. Agr. Bur. An. Ind. Ann. Rep., 1885, 212; Bacterium of hog cholera, Salmon, 1bid., 1886, 20; Bakterium der Schweinepest, Selander, Cent. f. Bakt., 3. 1888, 361; Pasteurella salmoni Trevisan, I generi e le specie delle Batteriacce, 1889, 21; Bacterium cholerae suis Th. Smith, U. S. Dept. Agr. Bur. An. Ind., Bull. 6, 1894, 9, Swine-feverbacillus, Klein, Cent. f. Bakt., I Abt , 18, 1895, 105; Bacillus suipestifer Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 401; Bacterium cholerae suum Lehmann and Neumann, Bakt, Diag. 1 Aufl . 2, 1896, 233; Bacterium suipestifer Chester, Ann. Rept. Del. Col. Agr. Exp Sta , 9, 1897, 70; Bacillus cholerae suum Migula, Syst d. Bakt., 2, 1900, 759; Le microbe du hog-cholera, Lignières, Bull Soc. Cent Méd. Vet., see Rec. de méd. vét., Paris, Sér 8, 7, 1900, 389; Bacillus salmoni Chester, Manual Determ Bact , 1901, 210; Bacterium intestinate suis Le Blaye and Guggenheim, Manuel Pratique de Diagnostic 1914, Bacillus suis Bacteriologique, Krumwiede, Kohn and Valentine, Jour. Med. Res., 38, 1918, 89, Bacterium (Salmonella) cholera surs Buchanan, Jour. Bact, 3, 1918, 53; Salmonella

suipestifer Castellani and Chalmer, Man. Trop. Med., 3rd ed., 1919, 933. Bacillus cholerae-suis Winslow, Kligle and Rothberg, Jour. Bact., 4, 1919, 476, Bacterium cholerae-suis Holland, Jour Bact., 5, 1920, 217; Bacillus paratybasus B (Arkansas type), Schütze, Lance, 2, 1920, 93; included in Group I suipestfer, Andrewes and Neave, Brit Jour. Exp. Path., 2, 1921, 157; Weldin, Ions Sta. Coll. Jour. Sci., 1, 1927, 155; 77; pus suipestifer Amerika, Kaufimann, 2bf. d. ges. Hyg., 25, 1931, 273, the American Salbonella suipestifer of many authors) From Latin, hog cholers.

Salmonella choleraesuis (Smith) Weldin is the type species of the genus Solmonella.

Rods: 0.6 to 0.7 by 2.0 to 30 microns, occurring singly. Motile with four to five peritrichous flagella. Gram-negative.

Gelatin colonies: Grayish, smooth, flat, glistening; margin irregular.

Gelatin stab: Flat, grayish surface growth. No liquefaction. Agar colonies: Grayish, moist, smooth,

translucent.
Agar slant: Grayish, moist, smooth,

Agar slant: Grayish, moist, smoot translucent growth.

Broth: Turbid, with thin pellicle and grayish-white sediment. Litmus milk: Slightly acid, becoming

alkaline, opalescent, translucent to yellowish-gray.

Potato: Grayish-white streak becoming brownish.

Indole not formed.

Nitrites produced from nitrates
Acid and gas from glucose, fructose,
glactose, mannose, xylose, maltose,
glycerol, mannitol, dulcitol, rhamnose,
sorbitol and dextrin. Arabinose, insitol, lactose, sucrose, saliem, nuhn,
raffinose and trehalose not attacked.

Reduces trimethylamine oxide (Wood and Baird, loc. cit).

Hydrogen sulfide not produced. Optimum temperature 37°C.

Aerobie, facultative Antigenie structure: VI, VII: c: 1,  Serologically identical with Salmonella typhisuis, and cross-agglutinates to a varying degree with a number of other serotypes

Habitat and source. Natural host the pig as an important secondary invader in the virus disease, hog cholera. Does not occur as a natural pathogen in other animals, although lethal for mice and rabbits on subcutaneous injection. Occasionally gives rise to acute gastroctritis and enteric fever in man.

30a. Salmonella choleraesuis var Kunzendorf Schütze et al.

The synonyms up to and including Weldin, 1927 for Salmonella choleraesuis apply equally well to the var. Kunzendorf, for these were not separated with certainty until 1926 (White, Med. Res Council, London, Spec Rep. Ser 103, 27). Re-examined serologically a number of previously described strains agree with this variety (Paratyphus C Bicillus, Heimann, Cent f Bakt , I Abt , Orig , 66, 1912, 211; Paratyphosus C, Weil and Saxl, Wien klin Wehnschr, 30, 1917, 519; Typus-suipestifer Kunzendorf, Pfeiler, Zischr. f Infektskr d Haust , 20, 1920, 218; Bacillus paratuphosus B, G type, Schütze, Lancet, 1, 1920, 93, Bacillus paratyphosus C, Dudgeon and Urquart, Lancet, 2, 1920, 15, included in Group II suspestifer, Andrewes and Neave, Brit. Jour Exp Path , 2, 1921, 157 and Group V of Hecht-Johansen, Copenhagen, 1923; Salmonella suspestifer (European variety) Schütze, Brit Jour Exp. Path , 11, 1930 31, Typus-suspestifer Kunzendorf, Kauffmann, Zbl f. d gen, Hyg , 25, 1931, 273, Salmonella choleraesus var. kunzendorf Schütze et al . Jour Hyg , 34, 1931, 311, the European Salmonella suspestifer of many authors )

Indistinguishable from Salmonella choleraceurs in morphology and cultural characters, except that the Kunzendorf variety forms hydrogen sulfide

Antigeme structure: VI VII-[c] 1,5

lacking the specific flagellar phase; serologically identical with Salmonella typhisuis var. roldagsen.

Source: From pigs with swine fever and once from a monkey in captivity. Habitat: Causes acute gastro enterity. and enteric fever in man. Also found in cattle, sheep, carnivora and chickens.

31. Salmonella typhisuis (Glässer) Schütze et al. (Bacıllus tuphisuis Glasser. Deutsche tierärztl. Wchnschr., 17. 1900, 513; included in the Ferkeltyphus bacilli of German literature, Dammann and Stedefeder, Arch, f. wiss, u. prakt. Tierheilk., 56, 1910, 432; Bacillus glässer Neukirch, Ztschr. f. Hyg, 85, 1918, 103; Bacterium typhi-suis Holland, Jour. Bact., 5, 1920, 221; included in Group I suipestifer, Andrewes and Neave, Brit. Jour. Exp. Path., 2, 1921, 157: Typus-Glässer, Kauffmann, Zbl. f. d. ges Hyg., 25, 1931, 273; Schütze et al , Jour. Hyg , 54, 1934, 342.) From Greek, typhus and Latin, pig.

Rods: 0 6 to 0.7 by 2 0 to 3.0 microns, occurring singly. Motile with four to five peritrichous flagella. Gram-nega-

Gelatin colonies: Grayish, smooth, flat, glistening, edge entire. No liquefaction.

Agar colonies Grayish, moist, smooth, translucent.

Broth: Turbid.

Litmus milk; Slightly acid or neutral. Indole not formed.

Nitrates produced from nitrates.

Forms gas slowly and sparsely from all substances. Growth poor on all ordinary media.

Acid from arabinose, x) lose and trenaise Delayed or variable fermentation from dextrin, maltose, rhemnose, dulcitol, sorbitol. Mannitol not fermented or very slowly. Inositol not fermented

No ILS produced

Optimum temperature 37°C.

Aerobic, facultative

Antigenic structure: Identical with Salmonella choleracruis, from which the organism differs in respect to arabinose and trehalose. Antigenic structure VI, VII: c: 1, 5....

Habitat: Infects only the pig.

31a. Salmonella typhisuis var. voldagsen Schütze et al. (Included in Ferkeltyphus bacilli, Dammann and Stedefeder, Arch. f. wiss u. prakt. Tierheilk., 26, 1910, 432; Bacillus voldagsen Neukirch, Ztschr f. Hyg., 85, 1918, 103; included in Group II suipestifer, Andrewes and Neave, Brit. Jour. Exp. Path., 2, 1921, 157; Typus-voldagsen, Kauffmann, Zbl. f. d. ges. Hyg., 25, 1931, 273; Salmonella typhisuis var. voldagsen, Schütze et al., Jour. Hyg., 34, 1934, 342; 1934, 342

Morphology and cultural characters identical with those of Salmonella tunhisuis.

Antigenic structure: VI, VII: [c]: 1, 5.... Identical with that of Salmonella choleraesuis var. Kunzendorf from which species the organism differs culturally.

Habitat: Infects only the pig.

32. Salmonella sp. (Type Thompson). (Thompson type of Salmonella, Scott, Jour. Hyg, 25, 1925, 393; Typus-Thompson-Berlin, Kauffmann, Zbl. f. d. ges. Hyg, 25, 1931, 273; Salmonella thompson Schutze et al., Jour. Hyg., 34, 1931, 343.) Named after the family involved in the outbreak.

Antigenic structure, VI, VII: k:

Source. Isolated from food poisoning in man. Also found in chickens and turkeys (Edwards and Bruner, Jour. Inf. Dis., 72, 1943, 64)

Habitat · Widely distributed in warmblooded animals

32a Salmonella sp. (Type Berlin) (Type Thompson) (Typus-Berlin, Kauffmann, Cent. f. Bakt., I Abt, Ref., 94, 1929, 282; Typus C Berlin, Boccker and Kauffmann, Cent. f. Bakt., I Abt., Orig., 148, 1930, 458, Typus-Thompson-Berlin, Kauffmann, Zbl. f. d ges. Hyg. 25, 1931, 273; Salmonella thompson var. berlin Schütze et al., Jour. Hyg., 34, 1934, 343.)

Antigenic structure: VI, VII: [k]: 1,

5....
Source: Isolated from food poisoning in man. Not known to be a natural pathogen of animals.

Habitat: A natural pathogen of man causing food poisoning

33. Salmonella sp. (Type Montevideo). (Salmonella montevideo Hormaeche and Peluffo, Arch. Urug. de Med., Cirug y Espec., 9, 1936, 673.)

Antigenic structure: VI, VII: g, m, s: -.

Source: Originally isolated from human sources in Montevideo from an age that died of an enterocolitis, and mesencire glands of healthy hogs; also reported from chickens and powdere eggs (Schneider, Food Research, II, 1946, 313).

Habitat: Apparently widely dis tributed.

34. Salmonella sp. (Type Oranieaburg). (Typus-Oranienburg, Kaufmann, Ztschr. i. Hys., 111, 1930, 233. Salmonella oranienburgensis Haupi, Ergebnisse der Hyg., 15, 1932, 673; Salmonella oranienburg Schütze et al., Jour. Hyg., 34, 1934, 343.)

Antigenic structure: VI, VII: m, t— Source: From the feces of a child ins children's home near Oranienburg. Later isolated from gastroenteritis in man. Also from quail, chickens and powderd eggs (Schneider, loc. etc.).

Habitat: Reported from human sources, from hogs and from birds.

Salmonella sp. (Type Virchon).
 Typus-Virchow, Kaulimann, Ziecht f. Hye., 111, 1930, 221; Salmonella ritchoveri Haupt, Ergebnisse der Hys., 1932, 673; Salmonella virchow Schütze et al., Jour. Hye., 34, 1934, 343.

Antigenic structure: VI, VII: r: l.

2, 3. . . .

Source: Isolated from food poisoning in a man at the Rudolf Virchow Hospital in Berlin.

Habitat: A natural pathogen of man

Salmonella sp. (Type Oslo), (Salmonella oslo Tesdal, Ztschr. f. Hyg., 119, 1937, 451.)

Antigenic structure: VI, VII: a: e,

Source: Isolated in Oslo, Norway from cases of gastroenteritis in man.

Habitat: Not reported from other sources as yet.

37. Salmonella sp. (Type Americont) (Salmonella americont Henning, Jour Hyg. 57, 1937, 561)

Hyg, 57, 1937, 561)
Antigenic structure: VI, VII: d: e, n, x...

Source. Originally isolated from chickens from Amersfoort, Transvaal. Later found in a human mived infection with Salmonella typhi murium

Habitat: Not reported from other sources as yet.

 Salmonella sp. (Type Braenderup).
 (Salmonella braenderup Kauffmann and Henningsen, Ztschr. f Hyg., 120, 1937, 640)

Antigenic structure VI, VII: e, h.

Source: Isolated from a case of human gastroenteritis in Braenderup, Denmark Also from a cat in the same home that had died from a diarrhoca. Reported later from So. Africa (see Kauffmann, Inc Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1911, 237).

Habitat Apparently widely distributed

39 Salmonella sp. (Type Potsdam) (Typus-Potsdam, Kauffmann and Mitsul, Ztschr. I Hyg., 111, 1930, 740; Salmonella potsdaments Haupt, Ergebmise der Hyg., 13, 1972, 673; Salmonella potsdam Schütze et al., Jour. Hyg., \$4,

Antigenic structure: VI, VII: 1, v:

Source: Isolated from food poisoning in man at Potsdam, Germany.

Habitat: A natural pathogen of man causing food poisoning.

Salmonella sp. (Type Bareilly).
 (Salmonella, Type Bareilly, Bridges and Scott, Jour. Roy. Army Med Corps, 50, 1931, 241;
 Salmonella bareilly Schüze et al., Jour Hyc., 54, 1934, 313

Antigenic structure: VI, VII: y: 1,

Source: Isolated in 1928 from cases of mild enteric fever that occurred in Bareilly, India. Also reported from chickens (Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1912, 235).

Habitat: A natural pathogen of man causing gastroenteritis and enteric fever. Widely distributed in fowls

41 Salmonella sp. (Type Hartford).
(Salmonella hartford Edwards and
Bruner, Jour. Inf. Dis., 69, 1911, 223.)
Antigenic structure: VI, VII: y:

e. n. x. . . .

Source: One culture isolated from the stool of a man with persistent diarrhoea by Dr. E. K. Borman, Hartford, Conn. Habitat: Not reported from other

sources as yet

42. Salmonella sp. (Type Mikawasima\*). (Solmonella barelly var. milavar.ma Hatta, Japan Jour. Exper. Med., 16, 1938. 201; Salmonella mukawasima Hormacche, quoted from Schütze et al., Proc. 3rd Internat. Cong Microbiol., 1940. 337; 1slos see Kauffmann, Acta Path. et Microbiol. Scand., 16, 1939, 317 and 504, 17, 1940, 429.

Antigenie structures: VI, VII; y:

\*Correct spelling according to Prof.

\*Correct spelling according to Prof Kejima. Source: Isolated from a rat by Prof. Kojima and Prof. Hatta, 1937.

Habitat: Not reported from other sources as yet,

43. Salmonella sp. (Type Tennessee), (Salmonella tennessee Bruner and Edwards, Proc. Soc. Exp. Biol. and Med, 50, 1942, 174.)

Antigenic structure: VI, VII: z<sub>2</sub>: —.
Source: Culture isolated from feces of
normal carrier by Dr. W. C. Williams,
State Dept. of Health, Nashville,
Tennessee.

Habitat: Also reported from turkeys and powdered eggs.

44. Salmonelia sp. (Type Concord). (Salmonelia var. concord Edwards and Hughes, Jour. Bact., 47, 1944, 574.)

Antigenic structure: VI, VII: 1, v: 1, 2, 3 . . .

Source: Two cultures isolated by Dr. J. R. Beach and one by Dr. C. U. Duckworth from fatal infections in chicks (U. S. A.) and one by Dr. Jean Taylor from the stool of a person affected with gastroenteritis (England).

Habitat: Also reported from turkeys.

45. Salmonella sp. (Type Infantis). (Salmonella infantis Wheeler and Borman, Jour Bact., 46, 1943, 481.)

Antigenic structure. VI, VII: r- 1, 5, . .

Source. Isolated at Hartford, Connecticut from the blood of an infant. Subsequently also from stools.

Habitat Not reported from other sources as yet.

 Salmonella sp. (Type Georgia).
 (Salmonella georgia Morris, Brim and Sellers, Amer Jour Pub. Health, 52, 1944, 1279; Seligmann, Saphra and Wassermann, Amer. Jour. Hyg, 40, 1944, 227)

Antigenic structure VI, VII b.

e, n, z<sub>15</sub> . . . Source Isolated by Miss Jane Morris

from the feces of a 16-year-old boy during routine examination of food handlers, State Dept. of Health, Atlanta, Georga

Habitat: Not reported from other sources as yet.

47. Salmonella sp. (Type Papua). (Salmonella papuana Wilcox, Edwards and Coates, Jour. Bact., 49, 1945, 514)

Antigenic structure: VI, VII. r. e, n, z<sub>15</sub>, ...

Source: Isolated by Lt. Goldwasser from human feces from Port Moresby in Papua. New Guinea.

Habitat: Not reported from other sources as yet.

48. Salmonella sp. (Type Richmond). (Salmonella richmond Moran and Edwards, Proc. Soc. Exp. Biol. and Med., 62, 1946, 294.)

Antigenic structure: VI, VII: y: 1, 2,

Source: Isolated by Mr. Forest Spindle in Richmond, Virginia from the feces of a child affected with gastroenteritis Habitat: Isolated as yet from human sources only.

49. Salmonella sp. (Type Cardif). (Salmonella cardif Taylor, Edward and Edwards, Brit. Med. Jour., 1945, i, 368) Antigenic structure: VI, VII: k. 1, 10. . . .

Source: Isolated from human case of gastroenteritis from Cardiff, Wales.

Habitat. Isolated as yet from human sources only.

50. Salmonella sp. (Type Daytons) (Salmonella daytona Moran and Edwards, Proc. Soc. Exp. Biol and Med. 62, 1916, 294)

Antigenic structure VI, VII k: 1,

Source: Isolated by Mrs Mildred Gslton from human feces from Daytons, Florida.

Habitat: Not known from other sources as yet.

51. Salmonella so. (Type Newport). (Paratyphus 8: Weil and Saxl, Wien Llin Wehnschr. 30, 1017 519: Bacillus naratunhasus B. Newport type, Schittze. Lancet 1, 1920, 93: Paratyphus Newport Bacillus, Kauffmann, Cent f Bakt, I Abt . Ref., 94, 1929, 282, Salmonella newnort Schütze, Brit, Jour, Exp. Path . 11. 1930. 34: Salmonella newvortensis Haupt, Ergebnisse der Hyg., 15, 1932.

673.) Antigenic structure: VI. VIII e. h

1.2.3 . Source. Isolated from food poisoning

in man. Newport, England

Jour Vet. Res . 6, 1945, 264)

Habitat. Widely distributed in man, eattle, hogs, chickens, etc. snakes (Hinshaw and McNeil, Amer

51a. Salmonella sp (Type Puerto Kauffmann (Jordan, Jour. Trop Dis , 14, 1934, 27, Kauffmann, Cent. f. Bakt., I Abt., Orig., 152. 1934, 162: Schütze et al . Jour Hyg., \$4. 1934. 344.)

Antigenic structure VI. VIII fe. hl 1. 2. 3 . .

This is regarded as a non-specific variant of Salmonella sp. (Type Newport) by Schütze et al. (Proc 3rd Internat. Cong Microbiol., New York, 1910, 833).

52 Salmonella sp. (Type Pueris) (Salmonella pueris Wheeler and Borman, Jour. Bact., 46, 1943, 481.)

Antigenic structure VI, VIII. e. h

1. 2. . . .

Source: Isolated at Hartford, Connecticut from anal snabbings of a 14year-old boy during an attack of gastroententia complicating measles

Habitat: Not reported from other sources as yet.

53. Salmonella sp. (Type Kottbus). (Salmonella newport var. Lottbus Kauffmann, Cent. f. Bakt., I Abt., Oric., 182. 1934. 162: Salmonella kottbus Schütze et al., Proc. 3rd Internat, Microbiol. Cong. New York, 1940, 834 )

Antigenic structure: VI, VIII: e. h. 1.5...

Source. From an acute case of pastroenteritis in Kottbus, Denmark

Habitat: Not reported from other sources as vet

54 Salmonella sp. (Type Muenchen). (Typus München, Mandelbaum, Cent. f. Bakt , I Abt., Ref , 105, 1932, 377; Salmonella muenchen Schütze et al. Jour Hye., \$4, 1934, 311.)

Antigenic structure: VI, VIII. d: 1. 2. .

Source: Isolated from a fatal case of enteric fover

Habitat, Widely distributed, Reported from man, rabbits, bors, camele and chickens (Kauffmann, Die Batterrologie der Salmonella Gruppe, 1941. 244)

543, Salmonella sp. (Type Oregon). (Salmonella oregon Edwards and Bruner, Amer Jour Hyg., 54, 1911, 21 )

Antigenic structure: VI, VIII: d: 1. 2.3 . .

Source, Six cultures, one isolated from a turkey by Dr. E. M. Dickinson and five from the mesenteric glands of apparently normal hogs by Dr H. L. Rubin. This is a minor type of No 51

Habitat Also reported from reptiles chickens and man. Also powdered eggs

55. Salmonella sp. (Type Manhattan). (Salmonella manhattan Isluntda and Bruner, Amer Jour Hyg , 34, 1911, 21 1 Antigenic structure: VI, VIII. d.

1. 5. . . .

Source: Two cultures, one isolated from a chicken by Dr L. D Bushnell. Manbattan, Kansas, and the other from a turkey by Dr. W. R. Hinshaw, Also

from reptiles, hogs and human sources (Edwards and Bruner, Jour. Inf. Dis., 72, 1942, 64).

Habitat: Apparently widely distributed.

Salmonella sp. (Type Litchfield).
 (Salmonella litchfield Edwards and Bruner, Jour. Inf. Dis., 66, 1940, 220.)

Antigenic structure: VI, VIII: 1, v: 1,2,3....

Source: Isolated from the liver of a young turkey poult from Litchfield, Minnesota by Dr. B. S. Pomeroy. Also isolated from a case of food poisoning in man by Miss Georgia Cooper.

Habitat: Not reported from any other source, as yet.

57. Salmonella morbificans (Migula) Haupt. (Bacillus bovis morbificans Basenau, Arch. I. Hyg., 20, 1894, 257; Bacillus morbificans bovis Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 389; Bacterium morbificans bovis Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 2, 1897, 70; Bacillus morbificans Migula, Syst. d. Bakt., 2, 1900, 747; Flavobacterium morbificans Bergey et al., Manual, 3rd ed., 1930, 147; Haupt. Ergebnise der Hyg., 15, 1930, 673; Salmonella bovis-morbificans Schutze et al., Jour. Hyg., 34, 1934, 344.)

Antigenic structure. VI, VIII: r: 1, 5....

Source: Originally isolated from a senticemia in a cow.

Habitat: Also found in rabbits and in gastroenteritis in man.

Salmonella sp. (Type Narashino).
 (Salmonella narashino Nakaguro and Yamashita, quoted from Kaufimann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 246.)

Antigenic structure: VI, VIII: a: e, n, x....

Source. From the blood and feces of a

person suffering from enteric feret, Found in Japan.

Habitat: Not reported from other sources as yet.

Salmonella sp. (Type Buenos Aires).
 (Salmonella bonariensis Monteverde, Nature, 149, 1942, 472.)

Antigenic structure: VI, VIII: i. e, n, x....

Source: Isolated by Dr. Monteverde, Buenos Aires from a mesenteric gland of a normal hog.

Habitat: Also reported from normal human carriers and from cases of gastroenteritis.

60. Salmonella sp. (Type Glostrup). (Salmonella glostrup Kauffmann and Henningsen, Acta Path. et Microb. Scand., 16, 1939, 99.)

Antigenic structure: VI, VIII: zn: e,

Source: Isolated from cases of gastroenteritis in a family in Denmark. Also affected their dog. Later isolated in Jugoslavia and in Palestine.

Habitat: Evidently widely distributed.

 Salmonella sp. (Type Duesseldorf).
 (Salmonella duesseldorf Hohn, Cent. f. Bakt., I Abt., Orig., 146, 1940, 218)

Antigenic structure: VI, VIII: z4, z2:

-.
Source: Isolated from two patients,

one of whom died. Found in Duesseldorf, Germany. Habitat: Not reported from other

Habitat: Not reported from other sources as yet.

62. Salmonella sp. (Type Tallahassee). (Salmonella tallahassee Moran and Edwards, Proc. Soc. Exp. Biol. and Med. 62, 1946, 294.)

Antigenic structure: VI, VIII: 20,

z<sub>12</sub>: —. Source: Isolated by Mrs. Mildred Galton from feces of gastroenteritis patients and from normal human carriers, Tallahassee. Florida.

Habitat: Not known from other sources.

63. Salmonella sp. (T) pe Gatun). (Salmonella gatuni Wilcox and Coates, Jour Bact., 51, 1946, 561.)

Antigenic structure. VI, VIII: b:

Source: Isolated from human feces from Gatun, Canal Zone.

Habitat: Not known from other sources as yet,

Salmonella sp. (Type Amherst)
 (Salmonella amherstuna Edwards and Bruner, Jour. Immunol, 44, 1942, 319.)
 Antigenie structure: (VIII). I, v. 1,
 . . .

Source. Isolated by Dr. II. Van Roekel from one of a group of poults affected with a fatal disease.

Habitat: Not reported from other sources as yet.

65. Salmonella sp. (Type Virginia). (Salmonella virginia Saphra and Seligmann, Proc. Soc. Exper. Biol. and Med., 58, 1945, 50)

Antigenic structure: (VIII): d: — Source. Isolated by F. Spindle, Richmond, Virginia from the feces of an adult person suffering from a distribute.

Habitat: Not known from other sources as yet.

60. Salmonella typhosa (Zopf) White. (Bacillus des Abdominal-Typhus, Therth, Arch. f. path. Anat., 81, 1880 and 83, 1881; Typhus bacillen, Gaffly, Mittell a d. knierl, Geuundheitsamte, 2, 1881, 372; Hacillus typhonus Zopf, Die Spultpile, 3 Auf., 1885, 126; not Bacillus typhonus Klebs, Handbuch d. path Anat., 1880; Bacillus typh Schneeter, in Colm, Kryptogamer Flora v. Schleeine, 3. 1886, 165. Bacillus tunhi abdominalis Flügge, Die Mikroorganismen, 2 Aufl., 1886, 198; Vibrio typhosus Trevisan, I generi e le specie delle Batteriacec, 1889. 23: Bacterium typhi Chester, Ann. Rept. Del. Col. Agr. Exp Sts., 9, 1897, 73; Bacterium typhosum Twort, Proc. Royal Soc., London, 79, B. 1907, 329; Acustia tuphi Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 517; Bacterium (Eberthella) tuphi Buchanan, Jour. Bact , 3, 1918, 53; Eberthus tuphosus Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 936; Eberthella typhi Bergey et al., Manual, 1st ed., 1923, 223; Eberthella turbosa Weldin. Iona State College Jour. Sci., 1, 1927. 170: Salmonella tuph: Warren and Scott. Jour Hyg., 29, 1930, 416; White, Jour, Hyg , 29, 1930, 443 ) Named from the disease, typhoid fever.

The species name typhosa should be used for the typhoid organism when it is placed in any genus other than Bacullus in spite of the earlier use of this species name by Klebs for a different organism. There are two reasons for this, (a) This appears to be the proper course to follow under International Illules of Nomenclature (See Art. 54, p 54) and (b) there is less chance for confusion regarding the nature of this organism among English-speaking persons who may careleasly interpret typhia as the name of a typhus rather than a typhoid bacillus.

Rods: 0 6 to 0.7 by 2 0 to 3 0 microns, occurring singly, in pairs, occasionally short chains. Motile with peritrichous flagella. Gram-negative.

Gelatin colonies. Gray ish, transparent to opaque, with leaf-like surface markings

Gelatin stab. Thin, white, opalescent growth. No liquefaction

Agar colonies: Grayish, transparent to opaque.

Agar slant: Whitish-gray, glistening, echinulate, entire to undulate growth

Broth: Turbid, moderate sediment and delicate pellicle in old cultures.

Litmus milk: Slight, transient acidity, followed by a return to neutral or to slight alkalinity.

Potato: Delicate, moist, slightly spreading, barely visible growth.

Acid but no gas from glucose, fructose, galactose, xylose, maltose, raffinase, dextrin, glycerol, mannitol and sorbitol. No action on lactose, sucrose, inulin, rhamnose, inositel, salicin and usually arabinose and dulcitol.

Reduces trimethylamine oxide (Wood and Bard, loc. ett.).

Indole not formed.

No characteristic odor.

Nitrites produced from nitrates.

Hydrogen sulfide produced.

Aerobic, facultative.

Optimum temperature 37°C.

Antigenie structure: IX, XII, [Vi]: d

The somatic antigens are related to those of Salmonella enteritidis and a number of other species of Salmonella. V and W forms are present (Felix and V and Wu. Path and Bact., 38, 1934, 409, Craigie and Brandon, Jour. Path. and Bact., 43, 1936, 233 and 239). Craigie and Yen (Canadian Public Health Journal, 20, 1938, 448 and 481) by the action of selected Vi phages recognize eleven distinct stable types of Salmonella typhosa which have been found to be of epidemiological importance

Source. From the human intestine.

Habitat The cause of typhoid fever Pathogenic for laboratory animals on parenteral injection Isolated once from a chicken by Henning, Onderstepoort, So Africa

Norn This species has previously been regarded as the type species of the genus Eberthella Buchanan (Acustia Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 317, Buchanan, Jour. Bact , 3, 1918, 53; Eberthus Castellant and Chalmers, Man Trop. Med., 3rd ed., 1919, 934; Lankoides Castellani and Chalmers, ibid., 938; Wesenbergus Castellani and Chalmers, ibid., 940)

67. Salmonella enteritidis (Gaertner) Castellani and Chalmers. (Bacilus enteritidis Gaertner, Correspond, d. Allgemein. Artal. Verein Thuringen, 17, 188, 573; Klebsiella enteritidis De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 923; Bacterium enteritids Chester, Ann. Rept. Del. Col. Agr. Etp Sta., 9, 1897, 68; Bacillus gaertner Morgan, Brit. Med. Jour., 1, 1905, 125; Castellani and Chalmers, Manusl Topo. Med., 3rd ed., 1919, 930.) Named for the disease, enteritis.

Rods: 0.6 to 0.7 by 2.0 to 3.0 microns, occurring singly, in pairs and occasionally in short chains. Motile with pertrichous flagella. Gram-negative.

Gelatin colonies: Circular, gray, translucent, granular, entire.

Gelatin stab: Abundant surface growth, No liquefaction.

Agar colonies: Circular, gray, translucent, moist, smooth, entire. Deskowitz and Buchbinder (Jour. Bact, 28, 1935, 294) describe a variant that produces a soluble yellow pigment where certain peptone is present in the agretantigenic structure not determined.

Agar slant: Grayish-white, opalescent, smooth, moist, undulate growth.

Broth: Turbid, with thin pellicle and grayish-white sediment.

Litmus milk: Slightly acid, becoming alkaline, opalescent, translucent to yellowish-gray.

Potato: Abundant, moist, yellowishbrown to brown growth.

Indole not formed.

Nitrites produced from nitrates.

Acid and gas from glucose, fructose, galactose, mannose, arabinose, sylose, maltose, trchalose, devtrin, glycenj, mannitol, dulcitol and sorbitol. Noacid or gas from lactose, sucrose, mulia, salicin, raffinose, adonitol and inositol. Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide produced.

No characteristic odor. Aerobic, facultative

Optimum temperature 37°C.

Antigenic structure: [I], IX, XII.

Source: First isolated from feces in an epidemic of meat poisoning at Frankenhausen, Germany.

Habitat: Widely distributed, occurring in man. Also in domestic and wild animals, particularly rodents

67a. Salmonella entertidis var. Danyaz. (Bahr. Deutsche tierärtil Wehnschr, 1928, 786 and 1930, 145, Typus-Gärtner Ratin, Kauffmann, Zul. f. d. ges. 119g., 283, 1931, 273, Salmonella entertidis var. danyaz, Schütze et al., Jour Hyg., 34, 1934, 345; Salmonella danyazı Gay et al., Agents of Disease and Host Reisriance, 1935, 650

Differs from Salmonella enteritulis only in its negative action on glycerol in

Stern's medium. . Source: Isolated by Danysz in 1900

Habitat: A natural pathogen of rodents and man.

67b Salmonella enteritidis var. Chaco (Savino and Menendez, Rev. Inst. Bact., 6, 1934, 347; Kauffmann, Ztschr. f. Hyg., 117, 1935, 401.)

Differs from Salmonella entertidis in its action on dulcitol when tested by the method of Bitter, Weigmann and Habs (Münch, med. Wehnschr, 73, 1926, 940)

Habitat and source: Isolated from cases of fever during the Chaco war, South America.

67c. Salmonella enteritidis var Essen (Hohn and Herrmann, Cent. f. Bakt., I. Abt., Orig., 135, 1935, 183; 151d., 134, 1935, 277; Kauffmann, Ztechr. f. Hyg., 117, 1935, 401)

Differs from Salmonella entertidis when tested by the method of Bitter, Weigmann and Habs (Münch, med. Wehnschr, 73, 1926, 910), giving a negative reaction with anabinose and dufcitol.

Habitat and source: Isolated from human gastroenteritis, ducks and duck

Note: Jansen (Cent. f Bakt., I Abt., Orig., 155, 1935, 421) states that the organism named by him Salmonella enteritidis var. Mulheum is in reality Salmonella enteritidis yar Essen.

67d. Salmonella enterstidis var. Jena. (Fournier, Rev. Immunolog., Paris, 6, 1940-41, 264)

Source: Isolated from purulent pleural fluid

Habitat Not reported from other sources as yet

68. Salmonella sp. (Type Dublin). (Bacillus entertidis Pesch, Cent, f. Bakt, I Abt, Ong, 98, 1926, 22; Dublin Type, White, Med Res Counc, Syst. of Bact, 4, 1929, 86 and White, Jour Hyg, 29, 1930, 443, Salmonella dublin Warren and Scott, Jour Hyg, 29, 1930, 445, Typus-Dublin-Kiel, Kauffmann, Zbl. f. d. ges. Hyg, 25, 1931, 273; Salmonella entertidis var dublin Schitze et al., Jour Hyg., 32, 1934, 315).

Antigenic structure I, IX, XII- g,

Source From meningitis in children (Pesch, loc. cit.) Also isolated by Dr. J. W. Bigger in Dublin, Eire from a fatal fever following a kidney operation. Typed by Dr. Bruce White (loc. cit.).

Habitat Found in man A natural pathogen of cattle Widely distributed in cattle and foxes

Two special fermentative (1) per belong here (1) Salmonella dublin 2 - Satmonella dublin var acera Kaufimann, (2) Salmonella dublin 3 - Salmonella dublin var, Leela Kaufimann (Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1911, 252).

69 Salmonella sp. (Type Rostock). (Gärtner-Poppe Typus, Rahr, Disch, Tierärzt, Wehnschr, 1930, 145; Typus Gärtner-Rostock, Kauffmann, Ztschr. f. Hyg., 111, 1930, 221; Salmonella enteritidis var. rostock Schutze et al., 34, 1934. 315; Salmonella rostockensis Haunt. Ergebnisse der Hyg., 13, 1932, 673.)

Antigenic structure: I, IX, XII: g. p. u: --.

Source: Originally isolated from cattle by Dr. Poppe in Rostock, Germany. Habitat: Not known to infect man.

70. Salmonella sp. (Type Moscow). (Paratypus C1, Weigmann, Cent. f. Bakt., I Abt., Orig., 97, 1925, Beiheft, 299; Salmonella Type Moscow, Hicks. Jour. Hyg., 29, 1929, 446; Salmonella moscow Warren and Scott, Jour. Hyg., 29, 1929, 446; Typus Gärtner-Moskow, Kauffmann, Ztschr. f. Hyg., 111, 1930, 229; Salmonella moscowaensis Haupt, Ergebnisse der Hyg., 18, 1932, 673; Salmonella enteritidis var. moscow. Schutze et al., 54, 1934, 345).

Antigenic structure, IX, XII: g, q: --. Source From patients with enteric fever. Isolated in Moscow, Russia.

Habitat Infects man, horses, cattle.

71 Salmonella sp. (Type Blegdam). (Salmonella blegdam Kauffmann, Ztschr. f. Hyg , 117, 1935, 431.)

Antigenic structure, IX, XII: g,

m, q: -

Source: Isolated in 1929, at State Serum Institute, Copenhagen from the blood of a pneumonia patient. Also found in the blood of a patient by Dr. Fournier, in Shanghai, China (Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 264).

Habitat: Not reported from other

sources as vet

72 Salmonella sp. (Type Berta). (Salmonella berta Hormaeche, Peluffo and Salsamendi, Arch. Urug de Med., Cirug. y Espec, 12, 1938, 277 ) Named in honor of Prof. Arnoldo Berta, Uru-

Antigenic structure IX, XII: f, g, t · --

Source: Isolated from the mesenteric glands of normal hors.

Habitat: Causes gastroenteritis in man. Also found in chickens

73. Salmonella sp. (Type Pensacola). (Salmonella pensacola Moran and Edwards, Proc. Soc. Exper. Biol, and Med., 59. 1945. 52.)

Antigenic structure: IX, XII: g, m, t: --.

Source: From a severe case of gastroenteritis in man.

Habitat: Not reported from other sources as yet.

74. Salmonella sp. (Type Claiborne). (Salmonella claibornei Wilcox and Lennox, Jour. Immunol., 49, 1944, 71.)

Antigenic structure: I, IX, XII: k. 1.5. . . .

Source: Culture isolated from human feces at Camp Claiborne, Louisiana.

Habitat: Not known from other sources as yet.

75. Salmonella sp. (Type Senda). (K type, Shimojo, quoted from Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 265; Atypical Paratyphosus A, Aoki and Salai, Cent. f. Bakt., I Abt., Orig., 95, 1925, 152; Sendai type, White, Med Res. Council, Spec. Rept. Ser. No. 103, 1926, 118; Salmonella sendaiensis Haupt, Ergebnisse der Hyg., 13, 1932, 673; Salmonella sendai Schütze et al , Jour. Hyg., 34, 1934, 345; Eberthella sp (Sendai Type) F. Smith, in Manual, 5th ed., 1939, 461.)

Antigenic structure: [1], IX, XII. s.

1, 5. . . . Source: Isolated in 1922 by K. Shimojo in Japan from a case of paratyphoid. Later isolated by Aoki and Sakoi from feces, urine and blood of typhoid patients.

Habitat: A natural pathogen of man causing enteric fever.

76 Salmonella sp. (Type Miami). (Salmonella miami Educards and Moran Jour. Bact., 50, 1945, 250 )

Antigenie structure: IX, XII: a: 1. 5....

Differ culturally and brochemically from organisms of Sendar Type (Ed. wards and Moran. Jour Bact., 50. 1945, 257),

Source. Twenty-four cultures isolated by Mrs. Mildred Galton in Florida. Fourteen cultures were from cases of acute gastroenteritis, one from a national with chronic diarrhoea, 4 from food handlers 4 from chimpanzees thought to be affected with Lacillary dysentery and one from mekles which coured an outhreak of food poisoning. One culture was from Borman Wheeler West and Mickle (Amer Jour Pub. Health \$5 1913 197) and was isolated from a case of gastrocateritie in Connecticut Another culture was from Seligmann. Saphra and Wassermann (Amer. Jour Hyg. 88 1913 225) and was isolated from a case of enteric fever

Habitat inparently widely distributed as a natural pathogen of man and apes

77. Salmonella sp. (Type Durban) (Salmonella durban Henning, Rhodes and Gordon-Johnstone, Onderstepoort Jour Vet. Sci. \n Ind , 16, 1911, 103, also ste Kauffniann Acta Path et Microbiol Scand . to 1912, 523 )

Anticenic structure IX, XII a e, n. z....

Source: Isolated by Dr J Gordon-Johnstone in Burban, So Africa from feers of a woman affected with gastro-

ententia Habitat: Not reported from other sources as yet

78. Salmonella sp. (Type Onarimon) (Salmonella onarimon Kisida, Kitasato Arch, of Paper Med , 17, 1910, 1.)

Antigenie formula I IX, XII b 1, 2 ...

Source: From the feces of a paraty-

phoid B carrier. Later found in other esses of enteric fever resembling typhoid

Habitat: Cause of a typhoid-like diennen in men

20 Salmanalla en Clama Pastia - 1

Antigenic structure; [1], IX, XIII.e. h · 1.5 . . .

May or may not produce indole (Kauff. mann. Die Bakteriologie der Salmonella. Grunne, 1941, 12.1

Source: From human enteric fever at Easthourne, England,

Habitat: A natural pathogen for man. Also found in turkeys.

80. Salmonella sp. (Type Papama), (Jordan, Amer. Jour. Trop. Med., 14. 1934. 27: Salmonella panama Kauffmann, Cent. f. Bakt., I Abt., Orig., 152. 1934, 160 )

Antigenie structure: I, IX, XII: I, v:

Source: From human food poisoning at Fort Amador, in Panama Canal Zone. Also isolated in New York City. Germany and Uruguay. Also in reptiles, hors and chickens (Eduards and Bruner, Jour. Inf. Dis., 72, 1943, 64).

Habitat: Apparently widely distributed.

Si. Salmonella sp. (Type Dar es Salaam). (Brown, Duncan and Henry, Lancet, 1, 1926, 117; Dar-es-Salaam Typus, Schütze, Arch. I. Hyg., 100, 1928, 192; Salmonella daressalaamensis Haupt, Ergebnisse der Hyg , 13, 1932, 673; Salmonella dar-es-salaam Schütze et al., Jour. Hyg., \$4, 1934, 316.)

Antigenic structure: I, IX. XII: 1, b : c. n. . . .

Liquelies gelatin (Jordan, Jour. Inf. Dis , 58, 1936, 126).

Source: Isolated by Butler in 1922 from a case of pyrevia at Dar es Salaam, Last Africa. Cultures have also been reported from Zanzibar.

Habitat: Known thus far from human sources only.

82. Salmonella sp. (Type Goettingen). (Salmonella goettingen Hohn, Cent. f. Bakt., I Abt., Orig., 146, 1940, 218.)

Antigenic structure: IX, XII: l, v: e, n,  $z_{15}$ ....

The complete formula was developed by Kauffmann (Acta Path. et Microbiol. Scand., 17, 1940, 429.)

Source: Not given. Presumably from a human source.

Habitat: Not reported.

83. Salmonella sp. (Type Java). (Salmonella javiana Alley and Pijoan, Yale Jour. Biol. and Med., 15, 1942, 229; Edwards and Bruner, Jour. Immunol., 44, 1942, 319.)

Antigenic structure. [I], IX, XII. I,

Z28: 1, 5. . . .

Source: From Eukman Institute in Java. Isolated from feces of a child. Subsequently two cultures labeled N112 and N140, isolated in Panama from human carriers, were received from Col. Chas G Sinclair.

Habitat. Reported as yet from human sources only.

84 Salmonella gallinarum Bergey et al (Bacillus gallinarum Klein, Cent f. Bakt., 5, 1889, 689; Pheasant bacillus, Klein, Jour Path, & Bact., 2, 1893, 214; Bacillus phasiani septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 410, Bacterium sanguinarium Moore, 12th and 13th Ann. Rpt. for 1895-96, U. S. Dept. Agr., Bur. An Ind., 1897, 188, see Moore, U. S. Dept. Agr. Bur An Ind , Bull. 8, 1895, 63; Bacıllus phasiani Migula, Syst. der Bakt, 2, 1900, 769, Bacterium phasiani septicus Chester, Ann Rept. Del. Col. Agr. Exp Sta., 9, 1897, 74; Bacterium gallinarum Chester, ibid, 80; Bacterium pyogenes sanguinarium Berry and Ernst, Jour. Med. Res., 10 (N S. 5), 1903-04, 402; Bacillus pseudo-cholerae gallinarum Trincas, Giorn, della R. Soc. Ital.

d'Igiene, 1908, 385; Bacillus typhi gellinarum alcalifaciene and Bacillus typhi gallinarum Pfeiler and Rehse, Mitt. K. Inst. f. Landw. Bromberg, 5, 1913, 306, Eberthella sanguinaria Bergey et al, Manual, 1st ed., 1923, 231; Bergey et al, Manual, 2nd ed., 1925, 236; Shiyella gellinarum Weldin, Iowa State Coll. Jour. Sci., 1, 1927, 179) From Latin, of chickens.

Bacterium jessersonii Hadley, Elkias and Caldwell, Rhode Island Agr. Exp. Sta. Bull. 174, 1918, 169 (Eberthdil jessersonii Bergey et al., Manual, 1st ed., 1923, 230; Shigella jessersonii Bergey et al., Manual, 4th ed., 1934, 394). Shigella jessersonii is identical serologically with Salmonella gallinarum (St. John-Broots and Rhodes, Jour. Path. and Bact., 15, 1923, 433).

Rods: 04 to 06 by 08 to 16 microzs, with rounded ends, occurring suggly or (in blood) in short chains. Non-motile

Gram-negative.

Gelatin colonies: Small, grayish-white, finely granular, circular, entire.

Gelatin stab: Slight, grayish white surface growth with slight grayish, filform growth in stab. No liquefaction Agar colonies: Moist, grayish, fireular,

Agar colonies: Moist, grayish, entire.

Agar slant: Thin, gray streek, with irregular margin, moist, glistening Broth: Turbid with heavy, flocculent

sediment.
Litmus milk: Reaction unchanged,

becoming translucent. No coegulation Potato: Slight grayish growth.

Indole not formed.

Nitrites produced from nitrates Acid but no gas frem glucose, fructose, galactose, mannose, xylose, arabinose, maltose, devtrin, mannitol, duicitol and isodulcitol. Lactose, sucrose, glycrol, sylicin and sorbitol are not attacked.

Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide is sometimes formed. Aerobic, facultative.

Optimum temperature 37°C.
Antigenic structure: [1], IX, XII:—:
—. Identical with Salmonella pullorum,

and related to Salmonella typhosa. [I] antigen noted by Kauffmann (Acta Path. et Microbiol. Scand., Suppl 54, 1944, 35).

Source and habitat The causative agent of foul typhoid (clearly to be distinguished from fowl cholers), and identical with Moore's infectious leukemia of fowls. Infectious for rabbits and all poultry, canaries and certain wild birds (quail, grouse, pheasant) by feeding or by injection. Found once in a partial human carrier.

85 Salmonella pullorum (Rettger)
Bergey et al. (Bacterum pullorum
Rettger, Jour. Med Res. 2t (NS 16),
1909, 117; also see Rettger, N. Y Med
Jour., 71, 1900, 803; ibid., 73, 1901, 267,
Rettger and Harvey, Jour Med Res.
18 (N S. 15), 1908, 277; Bacellus pullorum
Smith and Ten Broeck, Jour. Med. Res,
51 (N. S. 26), 1915, 547; Bergey et al.,
Manual, 1st ed., 1923, 218; Typus pullorum, Kaulimann, Zentbl. f d. ges
Hyg., 25, 1931, 273.) From Latin, of
cluckens

Rods: 0.3 to 0.5 by 10 to 25 microns, occurring singly Non-motile. Gramnegative.

Gelatin colonies: Grayish-white, moist, lobate, with grape-leaf surface. Gelatin stab Slight, grayish surface growth. No housefaction

Agar colonies Grayish-white, smooth,

Agar slant: Develops as discrete, translucent colonies. Broth Turbid.

Litmus milk: Acid, becoming alkaline No congulation

Potato: Slow development, grayish. Indole not formed.

Nitrites produced from nitrates
Acid and gas from glucose, fructuse,
galactose, mannose, arabinose, xylose,

mannitol and rhamnose. Does not at tack lactose, sucrose, maltose, dettrin, salicin, rallinose, sorbitol, adonitol, dulcitol or inositol. Gas may be slight or absent (cf. Salmonella gallinarum) Xylose may be fermented late (see Weldin, Iowa State Coll. Jour. Sci., 1, 1927, 165). Maltose fermenting strains may occur (Hinshaw, Browne and Taylor, Jour. Inf. Dis., 73, 1943, 197).

Reduces trimethylamine oxide (Wood and Baird, loc. cit.).

Hydrogen sulfide is formed.

Aerobic, facultative

Optimum temperature 37°C.

Antigenic structure, IX, XII —:
The complete antigenic formula of
S pullorum is IX, XII, XIII, XIII, while
that of S. gallinarum seems to be IX,
XII, XII, Antigen XII, 18 variable in
S pullorum (Edwards and Bruner, Cornell Vet., 35, 1916, 318) and XII, ++ and
XII, + forms occur The XII, ++ torms
are synonymous with the X strains of
Younic (Can. Jour Comp. Med., 5,
1911, 164)

Source: Isolated from chickens and other birds, as well as ealves, hogs, rabbits and man. Occasionally produces food poisoning or gastroenteritis in man (Mitchell, Garlock and Broh-Kahn, Jour. Inf. Dis., 79, 1916, 57).

Habitat: The cause of white diarrhoca in young chicks. Infects the ovaries and eggs of adult birds.

S5a. Salmonella gallinarum var. Duisburg. (Müller, Münch. med Wehnschr., 80, 1933, 1771; Kaufmann, Cent. f Bakt., I Abt., Orig., 132, 1931, 337.)

Antigenically identical with Salmonella callingram and Salmann, "

ferment d tartrate and in not forming II<sub>2</sub>S.

Source and habitat: Isolated from acute gastroenteritis in man

86 Salmonella sp. (Type Canastel). (Nalmonella canastel Randull and Bruner, Jour Bact., 49, 1915, 511.) Source of name not given.

Liquelies gelatin

Antigenic structure: IX, XII: #n: 1,5 ...

Source: Isolated in North Africa from American soldiers acting as food handlers.

Habitat. Not reported from other sources as yet

87. Salmonella sp. (Type Italia). (Salmonella staliana Bruner and Edwards, Proc. Soc. Exp. Biol. and Med., 58, 1945, 289.)

Antigenic structure: IX, XII: 1, v: 1, 11....

Source: Two cultures, one isolated from a case of bloody diarrhoea and the other from a case of gastroenteritis in man. Found in Italy by Lt. Col. Robert Hebble and by Capt. Ira C. Evans.

Habitat: Not reported from other sources as yet.

88 Salmonella sp. (Type Napoli). (Salmonella napoli Bruner and Edwards, Proc. Sov. Exper Biol. and Med., 58, 1945, 289)

Antigenic structure. [1], IX, XII: 1,  $z_{13}$  e, n, x. . . .

Source Ten cultures isolated from normal feces and from cases of gastroenteritis in Naples, Italy. The first culture was isolated by Capt. W. H. Enine.

Habitat. Not reported from other sources as yet.

89. Salmonella sp. (Type Loma Linda). (Salmonella loma linda Edwards, Proc. Soc. Eyper. Biol. and Med., 67, 1944, 104.)

Antigenic structure IX, XII. a. e,

Source Single culture isolated by Dr T F. Judefind, Loma Linda, California from the spinal fluid of a baby that died of meningitis.

Habitat: Not reported from other sources as yet

Salmonella sp. (Type New York)
 (Salmonella new york Kauffmann, Acta
 Path. et Microbiol Scand, Suppl. 54,
 1944, 35)

Antigenic structure: IX, XII: 1, v

Source: Found by Dr. F. Schiff, Ner York in a study of a culture received under the label S. panama Strain No 431 Regarded at the present time as a strain of Salmonella javiana by Dr. Kauffman (personal communication, March, 1947).

Habitat: Not reported from other sources as yet.

91. Salmonella sp. (Type London) (Salmonella Type L, White, Med Re. Council Spec. Rept. Ser. 103, 1925, 37; Salmonella Londonensis Haupt, Ergebnise der Hyg., 15, 1932, 675; Salmonella London Schütze et al., Jour. Hyg., 34, 1934, 36) Antigenie structure: III, X, XXII

1, v: 1, 6....
Source: Isolated in London from the feces of a gastroenteritis patient from

Reading, England.

Habitat: Found in human infections, in hogs and in chickens.

92. Salmonella sp. (Type Give). (Salmonella give Kauffmann, Ztschr. f. Ilys. 120, 1937, 177.)

120, 1937, 177.)
Antigenic structure: III, X, XXVI.

 y; 1, 7...
 Source: From feces of a patient with pernicious anemia. Also found in the U.S. A. and Germany. Occurs in Iosls and hogs (Edwards and Bruner, Jour. Int. Dis., 72, 1913, 64).

Habitat: Apparently widely distributed.

93. Salmonella sp. (Type Uganda) (Salmonella uganda Kaufmann, Acta (Path. et Microbiol. Scand., 17, 1940, 189.)

Antigenic structure: III, X, XXVI: 1, zu: 1, 5....

Source: Isolated in Uganda by Dr. H. G. Wiltshire from a human spices on autopsy Typed by Dr. F. Kauff-

mann.
Habitat: Not reported from other sources as yet.

94. Salmonella anatis (Rettger and Scoville) Bergey et al. (Bacterum anatis Rettger and Scoville, Abst. Bact., 3, 1910, 8, not Bacterium anatis Migula, Syst. d. Bakt., 2, 1900, 364; Bacterium anatum Rettger and Scoville, Jour Inf. Dus. 26, 1909, 217; Eechercha anata Bergey et al., Manual, 1st ed., 1923, 198; Bergey et al., Manual, 2nd ed., 1925, 223, Salmonella anatum Bergey et al., Manual, 3rd ed., 1930, 344.) From Latin, of the duck.

With the transfer of this organism to the genus Salmonella, the original species name anatis again becomes available in spite of the earlier use of this species name by Migula for Cornil and Toupet's Bacillus der Enten-cholera (Compt rend Acad Sci., Paris, 108, 1888, 1737) The latter organism is stated by Rettger and Scoville (1920, loc. ci., 220) to be indistinguishable from Pasteurella auseptica

Morphology and cultural characters
like those of Salmonella enteritois.

Kauffmann (Ztschr f. Hyg, 119, 1937, 352) describes a lactose-splitting variant of this species.

Antigenic structure. III, X, XXVI: e, h. 1, 6. . .

Reduces trimethylamine oxide (Wood and Baird (Ice. ett.).

Source: Isolated from an epizootic of keel in ducklings. Also found in intestinal infections in chickens and man Prequently occurs in association with Solmonella typhymyrium.

Habitat, Widely distributed in man

95 Salmonella sp. (Type Muenster, Kaufmonella anatum var muenster, Kauffmann and Silberstein, Cent. f. Bakt., I Abt., Orig., 132, 1934, 431; Salmonella muenster Kauffmann, Ztschr. f. Hyg., 120, 1937, 177)

Antigenie structure: III, X, XXVI e,

h 1, 5 ...
Source, Isolated by Dr. Besserer in
Muenster from food poisoning Also
isolated in Uruguay from human sources.

Habitat: Not known from any but human sources as yet.

96, Salmonella sp. (Type Nyborg), (Salmonella anatum var. nyborg, Kristensen and Bojlén, Cent. f. Bakt., I Abt., Orig., 150, 1936, 294; Salmonella nyborg Kaulimann, Ztschr f. Hyg., 120, 1937, 189.)

Antigenic structure · III, X, XXVI: e, h: 1. 7.

Source: From a case of acute enteritis in a young girl in Nyborg, Denmark.

Habitat. Known only from human sources as yet

97 Salmonellasp. (Type Vejle). (Salmonella vejle Harhoff, quoted from Kauffmann, Die Bakteriologie der Salmonella-Gruppe. Konenhagen. 1941. 274.)

Antigenie structure: III, X, XXVI:e,

h. 1, 2, 3...

Source: Isolated by E. Møller, Copenhagen, from a case of acute gastro.

enteritis.

Habitat: Not reported from other sources as yet.

98. Salmonella sp. (Type Meleagris). (Salmonella meleagridis Bruner and Edwards, Amer. Jour. Hyg., 34, 1941, 82, not Salmonella meleagridis Rettger, Plastridge and Cameron, Jour Inf Dis. 55, 1933, 279).

Antigenic structure: III, X, XXVI: e,

Source. Original cultures isolated by Dr B. S. Pomeroy, Univ. of Minnesota, from two distinct outbreaks of infection in turkey poults. Stated to be the same as Salmondla bankam from Ilatavia, Java (Kauffmann, Acta Path. et Mierobiol. Seand. 19, 1912, 5-29).

Habitat In addition to the two strains isolated in Minnesota (Bruner and Edwards, Kentucky Agr. Lip. Sta., Bull. 431, 1912), the same type was recognized among cultures received from Massachusetts, Michigan, Pennsylvania, Maryland, South America and Japun. Also isolated from German soldiers in

Norway by Tesdal (Kaufimann, Die Bakteriologie der Salmonella-Gruppe, 1941, 295) and from snakes by Hinshaw and McNeil (Amer. Jour. Vet. Res. 6, 1945, 264).

99. Salmonella sp. (Type Shangani). (Salmonella shangani Kauffmann, Acta Path. et Microbiol. Scand., 16, 1939, 347.) Antigenic structure: III, X, XXVI: d:

5.... Source: Isolated in Zanzibar by Dr.
 D. Robertson from a woman with

enteric fever.

Habitat: Known only from human sources as yet.

100. Salmonella sp. (Type Zanzibar). (Salmonella zanzibar Kauffmann, Acta Path. et Microbiol. Scand., 16, 1939, 347.) Antigenic structure: III, X, XXVI: k: 1.5....

Source: Isolated in Zanzibar by Dr. J. D. Robertson from a typhoid carrier. Habitat: Also found in chickens (Edwards).

101. Salmonella sp. (Type Amager). (Salmonella amager Kauffmann, Acta Path et Microbiol Scand., 16, 1939, 347.) Antigenic structure: III, X, XXVI: y:

1, 2, 3. . . .

Source: Isolated in Copenhagen from the feces of a person suffering from gastroenteritis

Habitat: Known only from human sources as yet.

102. Salmonella sp. (Type Lexington). (Salmonella lexington Rubin, Jour. Bact., 40, 1940, 463; Edwards, Bruner and Rubin, Proc. Soc. Exper. Biol. and Med., 44, 1940, 395.)

Antigenic structure III, X, XXVI; z<sub>10</sub>: 1, 5.

According to Kauffmann (Die Bakteriologie der Salmonella-Gruppe, 1941, 276), Dr. Erber of Java has found a Salmonella type with the same antigenic structure and has given it the name Salmonella batavia. Source: Isolated from mesentene lymph glands of apparently normal hogs by Dr. H. L. Rubin, Univ. of Kentucky, Lexington, Ky.

Habitat: Also reported from turkeys

103. Salmonella sp. (Type Weltevreden). (Salmonella weltevreden Mertens, quoted from Kauffmann, Acta Path et Microbiol. Scand., 19, 1942, 529)

Antigenic structure: III. X. XXVI

r: z. . . .

Source: Isolated by Dr. W. K. Mertens, Batavia, Java, according to Kauffmann (loc. cit.).

Habitat: Not recorded in available literature.

104. Salmonella sp. (Type Orion). (Salmonella type, var. orion and Salmonella orion Barnes, Cherry and Myers, Jour. Bact. 50, 1945, 578.) From a seaman on the S. S. Orion.

Antigenic structure: III, X, XXVI.

y: 1, 5.... Source: From rectal swab specimen from a normal food handler.

Habitat: Not reported from other sources as yet.

105. Salmonella sp. (Type Butantan). (Salmonella butantan Pelufio, Biet, Amaral, and Biocca, Mem. Inst. Butantan, 19, 1946, 211.)

Antigenic structure: III, X, XXVI.b

1, 5....
Source: Isolated by Dr. C. A. Peluffo
from a case of diarrhoea in a child.

Habitat: Not reported from other sources as yet.

106. Salmonella sp. (Type Newington) (Anatum C, No. 3071, N.C.T.C., London, Kauffmann and Silberstein, Cent., Ratt., I Abt., Orig., 152, 1934, 434; Salmonella newington Edwards, Jour.

Hyg., 37, 1937, 384.) Antigenic structure: III, XV: e, h:

1,6.... Source: Isolated from ducks from Newington, Connecticut by Dr. L. F. Rettger. Also found in hogs, silver foves and man. Kauffmann (Zischr. f. Hyg., 120, 1937, 177) has described a related type (Salmonella tim) from a case of entertis in Tun. Denmark.

Habitat Widely distributed.

107. Salmonella sp. (Type Selandia). (Salmonella selandia Kauffmann, Ztschr. f Hyg., 120, 1937, 189.)

Antigenic structure: III, XV: e, h:

Source: Isolated from the feces of a sailor on the S S. Selandia after a voyage to Asia and Australia. Was patient in Bispebjerg Hospital with pleuro-

pneumonia at the time.

Habitat. Known only from human sources as yet.

10S Salmonella sp. (Type New Brunswick). (Salmonella new brunswick Edwards, Jour. Hyg., 37, 1937, 384; also see

Kauffmann, Ztschr f. Hyg, 120, 1937, 189) Antigenic structure: III, XV: l, v

1, 7 . . Source: Isolated by Dr. F. R. Beau-

dette, New Brunswick, New Jersey from a chicken. Also isolated from gastroenteritis in man.

enteritis in man.

Habitat Apparently widely distributed

109 Salmonella sp. (Type Illinois) (Salmonella illinois Edwards and Bruner, Proc Soc Exper. Biol and Med., 48,

Proc Soc Exper. Biol and Med , 48, 1931, 240)
Antigenic structure. (III), (XV).

XXXIV 20. 1, 5 . . Source Isolated from bors in 1811

Source Isolated from hogs in Illinois by Dr. Robert Graham, from Hungarian partitidges in Michigan by Miss Virginia Stoney and from turkeys in Minnesota by Dr. B. S. Pomeroy

Habitat: Also reported from hogs and man (l'dwards)

110 Salmonella sp. (Type Senftenberg) (Typus Senftenberg, Kauffmann, Ztechr. f. llyg., 111, 1930, 221;

Salmonella senftenberg Schütze et al., Jour. Hyg., 34, 1934, 339; Salmonella senftenbergensis Haupt, Ergebnisse der Hyg., 15, 1932, 673.)

Antigenic structure. I, III, XIX: g, s, t: --.

Source: From a case of acute gastroenteritis in a boy in Senftenberg, Denmark. Cultures have frequently been found from persons and also from young turkeys

Habitat: Apparently widely distributed.

111. Salmonella sp. (Type Nilocse). (Salmonella nilocse Kauffmann, Acta path. et Microbiol. Scand., 16, 1939, 317)

Antigenic structure: I, III, XIX; d:

Source. Isolated in Copenhagen from a case of acute gastroenteritis in Niloese, Denmark. Later found frequently in gastroenteritis in Denmark.

Habitat: Known only from human sources as yet. 112 Salmonella sp. (Type Simsbury).

(Salmonella simsbury Bruner and Edwards, Proc. Soc. Exper. Biol. and Med., 50, 1942, 174.)

Antigenic structure: I, III, XIX. zn:

Source Original culture isolated by Dr. E. K Borman, State Dept. Health Lab, Hattford, Conn., from a normal human carrier from Simsbury, Conn., Liwards states (1916) that this may be a variant of Salmonella sp (Type Senftenberg).

Habitat Also found in turkeys (Bruner and Edwards, Kentucky Agr. Exp. Sta., Bull 434, 1942, 9).

113. Salmonella sp. (Type Taksony). (Salmonella talsony Rauss, Ztschr. f. Immunit\u00e9trforsch., 103, 1913, 220)

Antigenic structure, I, III, XIX: i.

Source Isolated from a healthy carrier (flungary).

Habitat: Not reported from other sources as vet.

114. Salmonella sp. (Type Kentucky). (Salmonella kentucky Edwards, Jour. Hyg., 58, 1938, 305.)

Antigenic structure: (VIII), XX: i: Za. . . .

Source: Isolated from the intestinal tract of a chick affected with coccidiosis and ulcerative enteritis. Found at Lexington, Kentucky,

Habitat: Also reported from many species of fowls, from hogs and from man (Edwards).

115. Salmonella so. (Type Aberdeen). (Salmonella aberdeen J. Smith, Jour, Hyg., 34, 1931, 357.)

Antigenic structure: XI: i: 1, 2, 3. . . . Source: Isolated in Aberdeen, Scotland, from the stool of a child suffering from acute enteritis. Also isolated by Timmerman in Utrecht from Ovomaltine, and by Edwards in Kentucky from birds See Kauffmann, Die Bakteriologie der Salmonella-Gruppe, Kopenhagen, 1941, 279,

Habitat: Apparently widely tributed

116. Salmonella sp. (Type Rubislaw). (Salmonella rubislam Smith and Kauffmann, Jour. Hyg., 40, 1940, 122.)

Antigenic structure: IX: r: e, n, x. . . . Source: Isolated in Aberdeen, Scotland from the feces of a child suffering from enteritis Also found by Tesdal in Oslo, Norway. Reported by Hinshaw and McNeil from snakes (Amer. Jour. Vet Res , 6, 1945, 264).

Apparently widely dis-Habitat tributed.

117. Salmonella sp. (Type Pretoria) (Salmonella pretoria Henning, Rhodes and Gordon-Johnstone, Onderstepoort Jour. Vet. Sci An. Ind , 16, 1911, 103.) Antigenic structure: XI: k: 1, 2, 3. . . .

Source: Isolated by Dr. M. W. Henning in Pretoria, South Africa from an infection in garbage-fed hogs.

Habitat: Not reported from other sources as vet.

118. Salmonella sp. (Type Venezia). (Salmonella veneziana Bruner and Jovce. Jour. Bact., 50, 1945, 371.)

Antigenic structure: XI: i: e. n. x. . . . Source: Culture received from Cant J. K. Hill. Isolated from an apparently normal Italian civilian food handler in Venice, Italy,

Habitate Not known from other sources as yet.

119. Salmonella sp. (Type Solt). (Solmonella solt Rauss, Ztschr. f. Immunitätsforsch., 103, 1943, 220.)

Antigenic structure: XI: y: 1, 5.... Source: Isolated from a healthy carrier (Hungary).

Habitat: Not reported from other sources as vet.

120. Salmonella sp. (Type St. Lucie) (Salmonella luciana Moran, Edwards and Bruner, Proc. Soc. Exp. Biol. and Med, 64, 1947, 89.) From St. Lucie, Florida. Antigenic structure: XI: a: e, n,

Z:5. . . . Source: Single culture isolated by Mrs

Mildred Galton from feces of a normal human carrier. Habitat: Not known from other

sources as yet.

121. Salmonella sp. (Type Senegal) Hinshaw senegal (Salmonella McNeil, Jour. Bact., 52, 1916, 319)

Antigenic structure: XI: r: 1, 5 ... Source: Isolated by Dr. W. L Ha-

shaw from a green mamba snake Habitat: Not known from other sources as yet.

122. Salmonella sp. (Type Marscille). (Salmonella marseille Moran, Edwards and Bruner, Proc. Soc. Exp Biol. and Med., 64, 1947, 89.)

Antigenic structure: XI: a: 1, 5...
Source: Isolated in Marseilles, France
by Cant. Wm. Sutton from feces.

Habitat: Not known from other sources as yet.

123. Salmonella sp. (Type Grumpy). (Salmonella grumpensis Hormacche and Peluffo, quoted from Hormacche et al., Jour Bact, 47, 1941, 323.) Named for a person called grumpy.

Antigenic structure: XIII, XXIII, XXXVI: d·1, 7...as given by Kauffmann (Acta Path. et Microbiol Scand., Suppl. 54, 1914, 37).

Source, Isolated in Uruguay from a guinea pig. Also studied by Kauffmann (loc cit)

Habitat: Not reported from other sources as yet.

121. Salmonella sp. (Type Poona) (Salmonella poona Bridges and Scott, Jour Roy Army Med Corps, 55, 1935,

Antigenic structure, XIII, XXII z.

Source: Isolated by Dr. L. Dunbar in Poona from the stool of a child suffering

from enteritis

Habitat: Also reported from hogs
(Edwards).

125 Salmonella sp. (Type Borbeck). (Salmonella borbeck Hohn and Herrimann, Cent. f. Bakt., I Abt., Orig., 145, 1940, 219.)

Antigenie structure XIII, XXII: 1, v 1, 6...

Source: I solated from the feces of a child with typhoid. Found in the Borbeck section of Essen, Germany. Habitat: Not reported from other

sources as yet.

126 Salmonella sp. (Type Mississippi).

(Salmonella mississippi Edwards, Cherry and Bruner, Proc. Soc. Exp. Biol. and Med., 54, 1943, 263.)

Antigenic structure: I, XIII, XXIII, b: 1, 5 . . . Source: Isolated by the State Dept. of Health of Mississippi from the stool of a normal food handler.

Habitat: Also reported from hogs (Edwards).

127. Salmonella sp. (Type Wichita). (Salmonella wichtla Schiff and Strauss, Jour. Inf. Dis., 65, 1939, 125.)

Antigenic structure: I, XIII, XXIII:

Source Isolated by Miss B. McKinlay in an epidemic of enteritis affecting babies, Wichita, Kansas Also in fowls, turkeys and hogs (Edwards and Bruner, Jour. Inf. Dis., 72, 1912, 64).

Habitat: Apparently widely dis-

tributed.

128. Salmonella sp. (Type Havana). (Salmonella harana Schiff and Saphra, Jour. Inf. Dis., 68, 1941, 125.)

Antigenic structure: I, XIII, XXIII: f, g: -.

Source: Isolated during an outbreak of 21 cases of meningitis in children in a maternity hospital in Havana, Cuba,

Habitat: Not reported from other sources as yet.

129. Salmonella sp. (Type Worthington). (Salmonella worthington Edwards and Bruner, Jour. Plyg., 38, 1938, 716.)
Antigenic structure: I, XIII, XXIII:

l, w. z. . . . Source: Isolated by Dr. B. S. Pomeroy

from a turkey poult from Worthington, Minnesota. Also found in a hen. Later additional cultures were found in other birds, in rodents, cattle, hogs and man. (Edwards and Bruner, Jour. Inf. Dis., 72, 1913, 64).

Habitat: Apparently widely distributed.

130 Salmonella sp. (Type Cuba). (Salmonella cubana Seligmann, Wasserman and Saphra, Jour. Bact., 81, 1016, 123)

Antigenic structure: I, XIII, XXIII:

Source: Isolated in Havana, Cuba by Dr. Arturo Curbelo from diseased baby chicks,

Habitat: Not reported from other sources as yet.

131. Salmonella sp. (Type Heves). (Salmonella heves Rauss, Ztschr. f. Immunitätsforsch., 103, 1943, 220.)

Antigenic structure: VI, XIV, XXIV: d: 1, 5, . . .

Source: Isolated from a healthy carrier (Hungary).

Habitat: Not reported from other sources as yet.

132. Salmonella sp. (Type Carrau). (Salmonella carrau Hormaeche, Felufio and Salsamendi, Arch. Urug. de Med., Cirug. y Espec., 12, 1938, 377; Hormaeche, Pelufio and Pereyra, Jour. Bact., 47, 1944, 323.)

Antigenic structure: VI, XIV, XXIV: y: 1, 7....

Source: Isolated in Uruguay from mesenteric glands of normal hogs.

Habitat: Also reported from feces and blood in man, once from flies and one culture from human blood from Mexico.

133 Salmonella sp. (Type Onderstepoort). (Salmonella onderstepoort Henning, Jour. Hyg., 36, 1936, 525.)

Antigenic structure: (I), VI, XIV, XXV: c. (h) 1, 5 ...

Source: Isolated in So. Africa by Dr. J. H. Mason from sheep in Onderstepoort. Also isolated from man by Dr. Hormacche (Uruguay) and from turkeys (Edwards, Kentucky)

Habitat Apparently widely distributed in warm-blooded animals

134 Salmonella sp. (Type Florida). (Salmonella florida Cherry, Edwards and Bruner, Proc. Soc. Exp. Biol and Med., 52, 1943, 1925; Galton and Quan, Amer. Jour. Hyg., 38, 1943, 173.)

Antigenic structure. (I), VI, XIV, XXV: d. 1, 7....

Source: Isolated by Mrs. Mildred Galton from feces of a patient with a febrile disease and diarrhoea.

Habitat: Also reported from reptiles (Edwards).

135. Salmonella sp. (Type Madela). (Salmonella madelia Cherry, Edwards and Bruner, Proc. Soc. Exp. Biol. and Med., 52, 1943, 125.)

Antigenic structure. (I), VI, XIV, XXV: y: 1, 7....

Source: A single culture isolated by Dr. B. S. Pomeroy from the liver of a poult that died of septicemia. Found in Madelia, Minnesota.

Habitat: Also reported from man (Edwards).

136. Salmonella sp. (Type Sundsvall) (Salmonella sundsvall Olin and Alin, Acta Path. et Microbiol. Scand, 29, 1943, 607.)

Antigenic structure: (I), VI, XIV, XXV: z: e, n, x....

Source: Isolated from a person suffer ing from gastroenteritis.

Habitat: Not reported from other sources as yet.

137. Salmonella sp. (Type Orient) (Salmonella orientalis Carlquist and Coute, Bull. U. S. Army Med. Dept, 6, 1946, 343.)

Antigenic structure: XVI · k: e, n,

Source: Isolated from U. S. Army personnel who had been prisoners of the Japanese Army in the Orient.

Habitat: Not known from other sources as yet.

138 Salmonella sp. (Type Hvittingfoss). (Salmonella hvittingfoss Tesdal, Ztschr. f. Hyg., 118, 1936, 533)

Antigenic structure: XVI. b: e, n,

Source: Isolated during a food poisoning outbreak in Hvittingfoss, a small town in Norway. Caused by eating

pultoste, a kind of soft cheese. Cultures secured from the cheese, from the persons who were poisoned, from sewage and from a foal.

Habitat: Evidently rather widely

130. Salmonella sp. (Type Gaminara). (Salmonella gaminara Hormseche, Pelusio and Salsamendi, Arch. Urug. de

Med, Cirug. y Espec., 12, 1938, 377; tbtd., 14, 1939, 217.) Named in honor of Prof. Gaminara of Uruguay. Antigenic structure: XVI; d: 1,7....

Source: Isolated from the feces of a child suffering from enteritis.

Habitat: Not known from other sources as yet.

140. Salmonella sp. (Type Szentes). (Salmonella szentes Rauss, Ztschr. f. Immunitätsforsch., 105, 1943, 220)

Antigenic structure: XVI: k: I, 2,

Source: Isolated by Dr. K. Rauss from a healthy carrier (Hungary).

Habitat: Not reported from other sources as yet.

141. Salmonella sp. (Type Kirkee). (Salmonella kirkee Bridges and Dunbar, Jour. Roy. Army Med. Corps, 67, 1936, 289.)

Antigenic structure: XVII:b: 1,2....
Source: Isolated in Kirkee, India from
the feces of a child suffering from acute
enteritis. The source of the infection
was thought to be a dog.

Habitat: Not reported from other sources as yet.

142. Salmonella ap. (Type Cerro). (Bacterium cerro Hormaeche, Peluflo and Salsanendi, Arch. Urug. Mc, Cirug. y Espec., 12, 1938, 317; Salmonella cerro Hormaeche, Peluflo and Aleppo, 19id., 19, 1941, 125)

Antigenic structure: XVIII: 24, 2m,

Source: Isolated from the mesenteric glands of normal hogs from Cerro, Urugusy. Habitat: Also isolated by the authors in 13 cases of infantile infections. Found also in chickens (Edwards).

143. Salmonella sp. (Type Minnesota). (Salmonella minnesota Edwards and Bruner, Jour. Hyg., 38, 1938, 716.)

Antigenic structure: XXI, XXVI: b: e. n. x. . . .

Source: Isolated in Minnesota by Dr. B. S. Ponercy from a young turkey.

Habitat. Also reported from cattle and man.

144. Salmonella sp. (Type Tel Aviv). (Salmonella tel-ariv Kaulimann, Acta Path. et Microbiol. Scand., 17, 1940, 1.) Antigenie structure: XXVIII: y: c, n, z<sub>11</sub> ...

Source: Isolated in Tel Aviv, Palestine by Dr. G. B. Simmins during an epizootic affecting young chickens during which 50 per cent died.

Habitat: Not known from other sources as yet

145. Salmonella sp. (Type Pomons). (Salmonella pomons Edwards, Proc. Soc. Exp. Biol. and Med., 58, 1945, 291.)

Antigenic structure; XXVIII; y: 1,

Source: Single culture isolated from the intestine of a poult in 1941 by Dr. W. R. Hinshaw.

Habitat: Also reported from man (Edwards),

146. Salmonella sp. (Type Ballerup), (Salmonella ballerup Kauffmann and Møller, Jour. Hyg., 40, 1940, 246.)

Antigenic structure XXIX, [Vi]:

Source: From the feces of a woman from the town of Ballerup, Denmark. A cause of gastroenteritis

Habitat: Not known from other sources as yet.

147, Salmonella sp. (Type Hormacche). (Salmonella hormacchei Monteverde, Nature, 154, 1911, 676) Named in honor of Dr. Hormacche of Uruguay. Antigenic structure: XXIX, [Vi]\*:  $z_{30}$ ,  $[z_{51}]$ : —.

Source: From the ovary of a hen whose blood gave a positive reaction with the S. pullorum antigen. Found in Buenos Aires by Dr. Monteverde.

Habitat: Also reported from hogs and man (Edwards).

\*Reported by Dr. P. R. Edwards (personal communication).

148 Salmonella sp. (Type Urbana). (Salmonella urbana Edwards and Bruner, Jour. Inf. Dis., 69, 1941, 223.)

Antigenic structure. XXX; b; e, n, x....

Source: One culture was received from Dr. Robert Graham, Urbana, Illinois and was isolated from the contents of the colon of a hog affected with hemorrhagic enteritis. The second culture was isolated from the intestinal tract of a chicken by Dr. W. L. Mallmann, East Lansing, Michigan

Habitat: Also reported from man (Edwards)

149 Salmonella sp. (Type Adelaide). (Salmonella adelaide Cleland, Med. Jour. Australia, 31, 1944, 59)

Antigenic structure XXXV; f, g: —. Source. Isolated in Adelaide, Australia by Miss Nancy Atkinson from two fatal cases resembling typhoid fever.

Habitat Not reported from other sources as yet

150 Salmonella sp. (Type Inverness). (Salmonella inverness Edwards and Hughes, Proc Soc Exp Biol and Med, 56, 1944, 33)

Antigenic structure XXXVIII: k

Source Isolated by Mrs. Mildred Galton and Mr M. S. Quan of the Florida State Department of Health, from the stool of a normal food handler, Inverness, Florida.

Habitat Not reported from other sources as yet

151. Salmonella sp. (Type Champaign) (Salmonella champaign Edwards, Proc. Soc. Exp. Biol. and Med, 58, 1945, 291.)

Antigenic structure: XXXIX: 1

Source: Single culture isolated from the liver of an adult hen by Dr. Robert Graham, Champaign, Illinois.

Habitat: Not reported from other sources as yet.

Appendix I: The following species and varieties are largely taken from Haudi roy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire des Bactérie Pathogènes, Paris, 1937, 446-472. The relationships of many of these are not clear.

Bacillus canariensis Migula. (Bicillus der Kanarienvögelseptikimie, Rieck, Deutsche Zischr. f. Thiermad, 15, 1889, 69; Migula, Syst. d. Bakt., f. 1900, 770; Bacillus avisepticus Chestr., Man. Determ. Bact., 1901, 220, vot & cillus gvisepticus Kitt, in Kolle and Wassermann, Handb. d. path. Mikroors, I Aufl., g. 1903, 544.) Associated with intestinal catarrh and liver changes in canaries. Hadley, Elkins and Caldrell (Rhode Island Agr. Exp. Sta, Bull 17, 1918, 178) regard this as probably & cullus gallinarum Klein.

Bacillus friedebergensis Kruse (Becillus der Friedeberger Fleischergftung, Gaffky and Paak, Mitt. a. & kaiserl. Gesundheitsamte, 6, 1850, 181, Kruse, in Flugge, Die Mikroorganisme, 3 Aufl., 2, 1896, 378; Bacterium fnetebergensis Chester, Ann. Rept. Del. Cd Agr. Exp. Sta., 9, 1897, 73) From sausage in meat poisoning.

Salmonella abortus canis Gard. (21sch. f. Hyg., 121, 1933, 130.) From the fees of four persons with paratyphoid apparently spread from an infected dy Kauflmann regards this as identical with Salmonella schottmuelleri.

Salmonella annamensis Hauduroy et sl. (Un bacille du groupe des Salmonells, Normet, Urbain and Chaillot, Compt. rend. Soc. Biol., Paris, 101, 1929, 73, Hauduroy et al., Diet. d. Bact. Path, 1937, 450) Isolated during an epidemic of dysentery at Huć (Annam) in 1925 Salmonella archibaldu. Castellani and

Chalmers. (Man. Trop. Med , 3rd ed., 1919, 940)

Salmonella carolina (Castellani) Castellani and Chalmers. (Bacillus carolinus Castellani, Ann di Med. Nav. e Colon., 1, 1918; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 940.)

Salmonella coggulans (Castellani) Hauduroy et al. (Bacillus coagulans Castellan, 1916, Balkanella coagulans Castellan, 1916; see Castellan and Chaters, Man. Trop. Med. 3rd ed., 1919, 935; Hauduroy et al., Diet d. Bact. Path., 1937, 453)

Salmonella columbensis (Castellani) Castellani and Chalmers. (Bacterium columbense Castellani, Proc. Meeting Ceylon Branch British Assoc., 1905, quoted from Castellani, Cent. f Bakt., I Abt., Orig., 74, 1914, 197; Bacillus columbensi Castellani, Jour. Trop Med and Hyg, 20, 1917, 181; Castellani and Chalmers, Ann. Inst. Past., 34, 1920, 609; Morganella columbensis Putton, Jour. Bact., 46, 1913, 81) The cause of columbenss fever. Isolated from feces, urine benss fever. Isolated from feces, urine

Solmonella enteritedis var. v., Hauduroy et al. (Baeılle para-Gărtner V., Rochaix and Couture, Revue de Microbiologie appliquée, g. 1936; Hauduroy et al., Diet. d. Bact. Path., 1937, 451.) Yound associated with Salmonella enteritedis in meat pies and in the fecces of individuals with food poisoning

and blood.

Salmonella enteratidis - ellow, a variety of Salmonella enteratidis Deskowitz and Buchlunder (Jour. Bact., 29, 1935, 293). Cultures differ from typical Salmonella enteritidis in producing a yellow, watersoluble pigment. From the feces of a rat with enteric infection.

Salmonella foetida Bergey et al. (Coccobecilius foetidus ocenae Perez, Ann. Inst. Past., 18, 1879, 397; Coccobencilius (foetidus) ozaenae Wartl, Jour. Bret., 2, 1917, 619; Bergey et al., Manual, 1st ed., 1923, 220, Bacterium foetida Weldun and Levine, Abst. Bact., 7, 1923, 13; Escherichia foetida Bergey et al, Manual, 2nd ed., 1925, 222) From chronic rhinitis, ozena. See Manual, 4th ed., 1931, 380 for a description of this species.

Salmonella holatientis Roeleke, (Also Salmonella Typ Holatein, Roeleke, Cent. I Bakt., I Abt., Orig., 137, 1936, 464.) According to Kaulimann (Zischr. I. Hyg., 119, 1937, 382) the O-antigeas of this rapid fermenter of salicin and weak induel-former are identical with those of Salmonella poona. The II-antigens have not been commared as yet.

Salmontila icteroides (Sanarelli) Bergey et al. (Bacillo icteroide, Sanarelli,
II Polichineo, 4, 1897, 412; Bacillus
icteroides Sanarelli, British Med. Jour.,
July 3, 1897, 7; Bacterium icteroides
Lehmann and Neumann, Bakl. Diagr.,
2 Audl, 2, 1899, 211; Bergey et al,
Manual, Ist ed., 1923, 215) From yellow fever cadavers. See Manual, 5th
ed., 1939, 601 for a description of this
species

Solmonella unojima Lindherg and Hayles. (Jour. Inf. Dis., 73, 1916, 92.) Isolated from a soldier on lwo-Jima during a routine examination of food handlers. Belongs to Group C. Antigenic structure: VI, VIII.ii.1,5... Described too recently to be included in the main body of the text.

Salmonella liceagi Leon. (Rev. Inst. Salubridad y Enferm. Trop. 3, 1912, 273.) From feces. This probably belongs in the coliform group.

Salmondla macfadycanii (Weldin and Levine) Weldin. (Bacterium macfadycanii Weldin and Levine, Abst. Bact 7, 1923, 13; Weldin, Iowa State Jour Sci. 1, 1927, 165) Associated with hog cholera.

Salmonella mexicana Varela and Olarte. (Rev. Inst. Subbrided y Enferm. Trop., 4, 1913, 313.) From feces

Salmonella rionshaui Carlquist and Coates (Jour. Bact. 53, 1917, 219) Isolated from stump of a soldier who suffered traumatic amputation of a leg in the fighting around Monshau, Germany. Belongs to Group F. Antigenic structure: XXXV: m. t .: Described too recently to be included in the main body of the text.

Salmonella nocardi Pacheco, (Compt. rend. Soc Biol., Paris, 106, 1931, 372 and 1018.) Pathogenic for parrots and pigeons.

Salmonella oahu Lindberg and Bayliss. (Jour. Inf Dis., 79, 1946, 92.) Isolated from a case of gastroenteritis in a soldier hospitalized on Oahu. Belongs to Group B. Antigenic structure: IV, V, XII: 1, v: 1, 2, 3 . . , Described too recently to be included in the main body of the text.

Salmonella ostrei (Besson and Ehringer) Hauduroy et al. (Bacillus ostrei Besson and Ehringer, Compt. rend. Soc. Biol., Paris, 87, 1922, 1017; Haudurov et al., Diet. d. Bact. Path., 1937, 460.) Isolated from oysters. Not pathogenic for laboratory animals.

Salmonella para-asiatica (Castellani) Hauduroy et al. (Bacillus paraasiaticus Castellani, 1916; see Castellani and Chalmers, Man. Trop. Med , 3rd ed., 1919, 950; Hauduroy et al., Dict. d. Bact Path , 1937, 461 )

Salmonella para-coagulans (Castellani) Hauduroy et al (Bacillus para-coagulans Castellani, 1914; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 950; Hauduroy et al., Dict. d. Bact Path., 1937, 461.)

Salmonella pauloensis Gomes. (Rev. Inst. Adolfo Lutz, 2, 1942, 231.) May be the same as Salmonella columbensis.

Salmonella pseudo-asiatica (Castellani) Castellani and Chalmers. (Bacillus pseudo-asiaticus Castellani, Cent. f. Bakt . I Abt . Orig., 65, 1912, 266; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 940.)

Salmonella pseudo-assatica var. mobilis Hauduroy et al. (Bacillus pseudoasiaticus mobilis Castellani, see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 952; Hauduroy et al., Diet. d. Bact. Path., 1937, 463.)

Salmonella (?) pseudo-carolina (Cas-

tellani) Hauduroy et al. (Bacillus pseu docarolinus Castellani, 1917; see Castellani and Chalmers, Man. Trop. Med. 3rd cd., 1919, 952; Hauduroy et al . Dict d. Bact. Path., 1937, 463.)

Salmonella (7)pseudo-columbenss (Castellani) Hauduroy et al. (Bacillus pseudo-columbensis Castellani, see Castellani and Chalmers, Man. Trop. Med. 3rd ed., 1919, 954; Haudurov et al. Diet. d. Bact. Path., 1937, 464.)

Salmonella pseudo-morganii (Castellani) Hauduroy et al. (Bacillus pseudomorogni Castellani, see Castellani and Chalmers, Man. Trop. Med., 3rd ed, 1919, 954; Hauduroy et al., Dict. d Bact, Path., 1937, 464.)

Salmonella ranicida Hauduroy et al (Bacille pathogène isolé des grenoulles, Gheorghiu and Balmus, Compt. rend Soc. Biol., Paris, 108, 1931, 1002; Hauduroy et al., Diet. d. Bact. Path., 1937, 466.) Pathogenic for frogs.

Salmonella saipan Lindberg and Bay liss. (Jour. Inf. Dis., 79, 1946, 92) Isolated from a case of gastroenteritis in a soldier hospitalized on Saipan Belongs to Group E. Antigenic struc ture: III, X, XXVI: z.... Described too recently to be included in the main body of the text.

Salmonella schottmülleri var. akti Hauduroy et al. (Bacillus paratyphi alvei Bahr, Skand. Veterin. Tidsk, 8, 1919; Hauduroy et al., Dict. d. Bact Path., 1937, 469.) Pathogenic for bees and wasps.

Salmonella veboda (Castellani) Castellani and Chalmers. (Bacillus reboda Castellani, Jour. Trop. Med. and Hyg 20, 1917, 181; Castellani and Chalmer Man. Trop. Med., 3rd ed., 1919, 93 Bacterium reboda Weldin and Levin Abst. Bact., 7, 1923, 13.)

Salmonella watareka (Castellani) Ber gey et al. (Bacillus watareka Castellan Rept. Advisory Committee for Trop Dis. Research Fund for 1912, London 1913; Bacterium walareka Weldin an Levine, Abst. Bact., 7, 1923, 13; Berge) et al., Manual, 1st ed., 1923, 219)

Salmonella ucrahensis (Castellani) Hauduroy et al. (Bacillus wcrahensis Castellani, seo Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 956, Hauduroy et al., Diet. d. Bact. Path., 1937, 471.)

Salmonella tesembergoides (Castellani) Hauduroy et al. (Bacillus wesembergoides Castellani, 1916, see Castellani and Chalmers, Man Trop Med., 3rd ed., 1919, 935; Hauduroy et al., Diet d Bact Path, 1937, 471.)

Salmonella uillegoda (Castellani) Castellani and Chalmers (Bacillus uillegoda Castellani; Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 939)

Salmonella voliniae (Castellan) Castellanı and Chalmers. (Bacıllus volniae Castellani, Jour. Trop Med. and Hyg. 29, 1917, 181; Castellanı and Chalmers, Man Trop Med. 3rd ed., 1919, 939; Bacterum voliniae Weldim and Levine, Abst Bact 7, 1923, 13)

Appendix II: The following species have been thought to belong to the genus Eberthella, i.e., do not produce grus from glucose. Descriptions of nearly all of the species listed in the genus Eberthella will be found in the Manual, 5th ed. 1939, 461-469.

Bacillus subentericus Ford (Studies from the Royal Victoria Hosp, Montreal, 1, 1903, 40; also see Jour Med Res. 1, 1901, 218) From feces

Bacterium typhi faitim Direct and Stuckl (Deutsche med. Wchinschr. 54, 1925, 517.) From feces of persons with typhoid fever. Crunckshamk (Jour Hyg. 55, 1933, 551) reports that a variety of yillow chromogenic suprophytes have been identified as belonging to this species, none of which could be regarded as yillow variants of Salmonella typhona (Loppl White: They apparently belong in the genus Flavobacterium Bergey et al.

Lberthella alcalifaciens de Salles. Goines (flivista do Inst Adolfo Lutz, 4, 1944, 191.) From estarrhal feces of an infant.

Eberthella belfastiensis (Weldin and Levine) Bergey et al. (Bacterium coli anaerogenes Lembke, Arch. f. Hyg., 26, 1896, 299, Bacterium lembles Migula, Syst. d. Bakt., £, 1900, 417; Bacterium anaerogenes Chester, Man Determ, Bact., 1901, 135, Bacillus belfastiensis II. Wilson, Jour. Hyg., 8, 1908, 543; Bacillus anaerogenes Holland, Jour. Bact., 5, 1920, 217; Bacterium belfastiensis Weldin and Levine, Abst Bact., 7, 1923, 13. Bergey et al , Manual, 1st ed , 1923, 226; Bacillus coli angerogenes Kerrin, Jour. Hyg., 23, 1928, 4: Escherichia anaerogenes Bergey et al., Manual, 3rd ed., 1930, 321; Castellanus colianaerogenes Castellani. Cent f. Bakt., I Abt , Orig , 125, 1932, 42.) From feces

Eberhella bentolennis (Castellani) and Chalmers) Repey et al. (Bacilus bentotensis Castellani, Cent. f. Bakt., I. Abt., Orig., 63, 1912, 262; Bacterium bentolensis Weldin and Levine, Abst. Bact., 7, 1023, 15; Bergey et al., Manual, 1st. ed., 1023, 227, Castellanus bentolensis Castellani, Cent. f. Bakt., I. Abt., Orig., 125, 1932, 42.) From the intestinal canal

Eberthella chylogena (Ford) Bergey et al. (Bacillus chylogenes Ford, Studies from the Royal Victoria Hospital, Montreal, 1, No. 5, 1903, 62; Bergey et al., Manural, 1st ed., 1923, 221) From the intestinal canal

Eberhella duba (Chester) Bergey et al (Mener Bakterie, Bleisch, Zischr, f. Hyg., 13, 1813, 31; Bacillus dubus Kruse, in Flügge, Die Mikroorganismen, 3 Mil. 2, 1903, 323; Bacillus bleischu Kruse, ibid., 701; Bacterium dubus Chester, Ann Hept. Del Col. Agr. Exp. Sta., 9, 1807, 93; Bergey et al., Manual, 1st ed., 1923, 225) From the intestinal canal.

Eberthella enterica (Ford) Bergey et al. (Hacillus entericus Ford, Studies from the Royal Victoris Hospital, Montreal, 1, No. 5, 1903, 40; also see Jour. Med. Research, 1, 1901, 211; not Bacillus entericus Castellani, 1907 (Enteroides entericus Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 911); Bergey et al., Manual, 1st ed., 1923, 223.) From the intestinal canal.

Eberthellainsecticola Steinhaus. (Jour. Bact., 42, 1941, 762 and 769.) From the intestinal tracts of grasshoppers, milkweed bugs and stinkbugs.

Eberthella kandiensis (Castellani) Bergey et al. (Bacillus kandiensis Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 262; Eberthus kandiensis Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 936; Bacterium kandiensis Weldin and Levine, Abst. Bact., 7, 1923, 13; Bergey et al., Manual, 1st ed., 1923, 225.) From feces.

Eberthella lewisii Weldin. (Organism B32, Lewis, Local Gov. Board Rept. Med. Suppl. London, 1910-11, Appen. B, No. 2, 1911, 314; Bactersum lewisii Weldin and Levine, Bact. Abst , 7, 1923, 13; Weldin, Iowa State Col. Jour Sci. 1. 1926, 172.) From feces of a normal child.

Eberthella oedematiens Assis (Boletin do Inst. Vital, Brazil, 5, 1928) From

the intestinal canal.

Eberthella oxuphila (Ford) Bergey al. (Bacterium oxyphilum Ford, Studies from the Royal Victoria Hospital, Montreal, 1, No. 5, 1903, 49; Bergey et al., Manual, 1st ed., 1923, 224 ) From the intestinal canal.

Eberthella pauloensis Mello. (Jornal dos Clinicos, Rio de Janeiro, No. 18-30, Sept., 1937, 7 pp ) From feces of a

dysentery patient.

Eberthella priztnıtzı (Castellani and Chalmers) Hauduroy et al. (Bacillus prizinitzi Castellani, Jour. Trop. Med. and Hyg., 20, 1917, 182; Eberthus priztnitzi Castellani and Chalmers, Man Trop. Med , 3rd ed., 1919, 936; Bacterium priztnitzi Weldin and Levine, Abst. Bact., 7, 1923, 13, Hauduroy et al., Dict. d. Bact. Path., 1937, 186.) From cases of paraenteric fever.

Eberthella proteosimilis Wassilien

(Cent. f. Bakt., I Abt., Orig., 151, 1944, 423.) Colonies show motility on agar. From feces of a dysentery patient.

Eberthella pyogenes (Migula) Bergey et al. (Bacillus pyogenes foetidus Passet, Fortschr. der Med., 1885: Bacillus foetidus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; Bacterium pyogenes foetidus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 141. Bacterium pyogenes Migula, Syst. der Bakt., 2, 1900, 381; Lankoides pyogenes Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 938; Bacillus pyogenes-foetidus Holland, Jour. Bact, 5, 1920, 220; Bergey et al., Manual, 1st ed., 1923, 226; Castellanus pyogenes Castellani, Cent. f. Bakt., I Abt., Orig., 125, 1932, 42.) From a rectal abscess.

Eberthella talavensis (Castellani) Bergey et al. (Bacillus talarensis Castellani, Cent. f. Bakt., I Abt., Ong, 65, 1912, 262; Eberthus talavensis Castellani and Chalmers, Man. Trop. Med, 3rd ed., 1919, 936; Bactersum talavensis Weldin and Levine, Abst. Bact., 7, 1923, 13; Bergey et al., Manual, 1st ed , 1923, 225.) From the intestinal canal

Eberthella tarda Assis. (Boletin do Inst. Vital, Brazil, 5, 1928.) From the

intestinal canal.

Eberthella wesenbergi (Castellani and Chalmers) Hauduroy et al. (Bacillus wesenberg Castellani, 1913; Wesenbergus wesenbergi Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 940, Hauduroy et al., Dict. d. Bact. Path , 1937, 191.)

Eberthella wilsonii Weldin. (Bacillus belfastiensis V, Wilson, Jour. Hyg, 8, 1908, 543; Weldin, Iowa State Col. Jour Sci., 1, 1926, 174.) From feces.

Eberthella xenopa Schrire. (Trans Royal Soc. So. Africa, 17, 1928, 43)

From wound infection in frogs.

Wesenbergus fermentosus Castellani and Chalmers. (Man. Trop. Med , 3rd ed., 1919, 940) From blood Isolated by Archibald in the Anglo-Egyptian Sudan

### Genus II. Shigella Castellani and Chalmers.\*

(Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 936; subgenera, Fleznerella and Shigella, Castellani and Chalmers, ibid., 938, Castellanus Carruti, Jour. Trop. Med. and Hyg., July 15, 1930, Proshigella Borman, Stuart and Wheeler, Jour. Bact., 48, 1944, 363) Named for Prof. I. Shiga, the Japanese bacteriologist who discovered the dysentery bacillus in 1859.

Non-motile rods, although cultures of some of the less well-known species have been reported as motile. Produce acid but no gas from earbohydrates except with some types of Shngella paradigenteriae. Do not liquefy gelatin. Some species produce and from lactose and form indole. Some species reduce trimethylamine oxide to trimethylamine, others do not † Some species will grow at 45.5°C (Eighman test) ‡ Pathogenic (causing dysenteries) or non-pathogenic species, all living in the bodies of warm-blooded animals. Carned by polluted nater supplies and by fises.

The type species is Shigella dysenteriae (Shiga) Castellani and Chalmers.

## Key to the species of genus Shigelia.\*\*

- I. No acid from mannitol.
- A. No acid from lactose. Milk not coagulated.
  - 1. Indole not produced.
    - Acid but no gas from glucose.
- Shigella dysenteriae.
- an Acid and a small amount of gas from glucose.

  4a. See Shigella paradysenteriae
  (Type Newcastle).
- 2. Indole produced

- 2. Shigella ambigua.
- B. Acid formed slowly from lactore.
  - 1 Indole not produced
- 3. Shigella gintottensis.
- Acid from mannitol (one type produces a small amount of gas).
  - A No acid from lactose
    - 1 No acid from rhamaose, vylose or dulcitol.
    - 4. Shigella paradysenteriae.

      2. Acid from rhamnose, vylose and dulcitol.
    - 3. Acid from tylose but not from dulcitol,
- 5. Shigella alkalescens.

  6. Shigella pfaffii.
  - B. Acid formed slowly from lactore.
    - 1. Indole not produced
      - a Acid from rhamnose None from xylose.

        7. Shigella sonnei.
    - aa. No acid from rhamnose Acid from xylose
- 8 Shigella equirulis.

Completely resised by Dr. Prederick Smith, McGill University, Montreal, P. Q.,
 Canada, December, 1938; further revision, April, 1946.

<sup>†</sup> Wood, Baird and Keeping, Jour. Bact , 46, 1913, 105

Stuart and Rustigian, Jour. Bact., 49, 1943, 105

<sup>\*\*</sup> See Weil, Jour Immunology, 55, 1917, 363-465

- 2. Indole produced.
  - a. Acid from dulcitol.
- aa. No acid from dulcitol.
- Action on mannitol unknown.
   A. No acid from lactose.
  - 1. Indole is produced.

- Shigella ceylonensis.
- 10. Shigella madampensis.
- 11. Shigella septicemiae

 Shigelia dysenteriae (Shiga) Castellani and Chalmers. (Bacillus of Japanese dysentery, Shiga, Cent. f. Bakt., I Abt., 23, 1898, 599; Bacillus dysenteriae Shiga, Cent. f. Bakt., I Abt., 24, 1898, 817; Bacıllus japanıcus Migula, Syst. d. Bakt., 2, 1900, 755; Bacillus shigae Chester, Man. Determ. Bact., 1901, 228; Bacillus dysentericus Ruffer and Willmore, Brit. Med. Jour., 2, 1909, 862; Bacterium dysenteriae Lehmann and Neumann, Bakt. Diag., 5 Aufl., 2, 1912, 348; not Bacterium dysenteriae Chester, Man. Determ. Bact., 1901, 145; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 935; Bacterium shigae Holland, Jour. Bact , 5, 1920, 220; Eberthella dysenteriae Bergey et al., Manual, 2nd ed , 1925, 250 ) Latinized, of dysentery.

Rods 0.4 to 0.6 by 1.0 to 3.0 microns, occurring singly. Non-motile. Gramnegative.

Gelatin colonies: Small, grayish, smooth, homogeneous, entire to slightly undulate.

Gelatin stab Grayish surface growth. No liquefaction.

Agar slant. Grayish, filtform to echinulate, smooth, entire to undulate growth. Broth: Slightly turbid, with grayish sediment.

Litmus milk: Slightly acid, then alkaline.

Potato. Delicate, grayish to slightly brownish streak.

Indole not produced.

Nitrites produced from nitrates. Acid but no gas from glucose, fructose, raffinose, glycerol and adonitol. Does not attack arabinose, xylose, maltose, lactose, sucrose, salicin, mannitol, dul citol or rhamnose.

Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1943, 106) Aerobic, facultative.

Optimum temperature 37°C. Does not grow at 45.5°C (Eijkman's reaction, Stuart et al, Jour. Bact., 46, 1943, 195). Serologically homogeneous and differ-

ent from the other species of Shigella.

Forms a potent exotoxin.

Source: From widespread epidemics of

Source: From widespread epidemics of dysentery in Japan. Habitat: A cause of dysentery in man

and monkeys.

2. Shigella ambigua (Andrewes) Wel-(Bazıllus Schmitz, Schmitz, din. Ztschr. f. Hyg., 84, 1917, 449; Bacillus ambiguus Andrewes, The Lancet, 194, 1918,560; Bacillus dysenteriae "Schmitz", Jour. Roy. Army Med. Murray. Corps, \$1, 1918, 257; Bacterium ambiguum Levine, Abst. Bact., 4, 1920, 15; not Bacterium ambiguum Chester, Del. Col Agr. Exp. Sta. Ann. Rept., 11, 1900, 59; Eberthella ambigua Bergey et al., Manual, 1st ed., 1923, 229; Bacillus paradysenteriae X, Stutzer, Cent. f. Bakt, I Abt., Orig., 90, 1923, 12; Bacterium schmitzii Weldin and Levine, Abst Bact , 7, 1923, 13; Weldin, Ions State College Jour. Sci., 1, 1927, 177; Shigella schmitzii Hauduroy et al., Diet d. Bact. Path , 1937, 496 ) From Latin, uncertain.

Morphology and colony characters indistinguishable from those of Shigelli dysenteriae.

Acid from glucose and rhamnose

Does not attack xylose, maltose, lactose, sucrose, dextrin, glycerol, mannitol or dulcitol.

Indole is produced.

Does not reduce trimethylamine oxide (Wood et al., Jour Bact , 46, 1943, 106). Acrobic, facultative

Optimum temperature 37°C

Docs not grow at 45 5°C (Stuart et al , Jour Bact., 46, 1913, 105).

Scrologically homogeneous and different from the other species of Shigella. Does not form an exotoxin

Source, Found in feces in a dysentery epidemic in a prison in Germany.

Habitat. A cause of human dysentery

3 Shigella gintottensis (Castellant) Hauduroy et al. (Bacillus gintottensis Castellani, 1910; see Castellani and Chalmers, Man. Trop Med , 3rd ed , 1919, 918, Lankoides gintottensis Castellant and Chalmers, shid., 938, Castellanus gintottensis Castellani, 1930, Castellani, Jour Trop Med. and Hyg. 56, 1933, 100; Haudutoy et al , Diet d Bact Path , 1937, 488 1

Rods, Non-motile, Gram-negative Morphology and cultural characters indistinguishable from those of Shigella dysenteriae.

Litmus milk. Acid and congulation; decolorized.

Indole not formed.

Acid, but no gas, from lactose, glucose, arabinose and galactose. No acid from sucrose, dulcitol, mannitol, maltose, dextrin, raffinose, adonitol, inulin, sorbitol, levulose, inoutol, salicin and gly cerol.

Antigenic structure not known

Source. From feces in cases of dysen-

Habitat, A cause of human dysentery

4 Shigella paradysenterlae (Collins) Welden (Bacillus dysenteriae Plexner, Phil Med Jour., 6, 1900, 414, Bacillus dysenteriae Hiss and Russell, Medical News, 82, 1903, 280; Bacillus dysenterine Strong, Jour Amer Med. Assoc , 35, 1906, 498; Bacillus paradysenteriae Collins, Jour. Inf. Dis., 2, 1905, 620; includes weakly toxic strains of dysentery bacilli. Groups I and II, Sonne, Cent. f. Bakt., I Abt , Orig., 75, 1915, 408; Shigella flexneri Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 937; Shinella dysenteriae (Hiss and Russell, and Strong types) Castellani and Chalmers, ibid... 937, not Shigella paradysenteriae Castellanı and Chalmers, abid., 937; Bacillus flexneri Levine, Jour. Inf. Dis , 27, 1920, 31: Bacterium flexneri Levinc, Abst. Baet., 4, 1920, 15; Bacterium dysenteriae (Flexner type) and Bacterium paradusenterrae Holland, Jour Bact., 5, 1920, 215: Eberthella flezneri Weldin and Levine. Abst Bact., 7, 1923, 13; Eberthella paradysenteriae Bergey et al., Manual, 1st ed . 1923, 230; Weldin, Iowa State College Jour Sci , 1, 1927, 178 ) Latinized. like dysentery.

Rods, 0 5 by 1 0 to 1.5 microns, Nonmotile. Gram-negative.

Morphologically these organisms are like Shigella dusenteriae.

Culturally these organisms differ from Shigella dysenteriae in that they ferment mannitol No acid is produced from lactose, rhamnose, vylose or dulcitol.

Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1913, 106).

Does not form a potent evotoxin Aerobie, facultative

Optimum temperature 37°C Docs not grow at 45 5°C (Stuart et al . Jour. Bact., 46, 1013, 105)

Antigenically the organisms of this species are not homogeneous

Boyd (Trans Roy Sec. Trop Med. and Hyg., 55, 1940, 553) has shown that the mannitol-fermenting She sella melude many organisms previously unknown or unclassified because they did not agree with the classical types of Andre ves and Inman (Med. Res Council, Special Rept Ser. No 42, London, 1919). With these, on grounds of antigenic structure. will be included the gas-forming Manchester bacillus of Donnie, Wade and Young (Jour. Hyg., 35, 1933, 196) and both mannitol-fermenting and non-fermenting Newcastle bacilli (Clayton and Warren, Jour. Hyg., 28, 1929, 355 and 29, 1929, 191).

The following tables are taken from Boyd (loc. cit.).

New Name	Old Name		
Bacıllus dysenteriae Flexner I	Andrewes and Inman V (Flexner)		
Bacillus dysenteriae Flexner II	Andrewes and Inman W		
Bacillus dysenteriae Flexner III	Andrewes and Inman Z		
Bacıllus dysenteriae Flexner IV	Type 103		
Bacillus dysenteriae Flexner V	Type P 119		
Bacillus dysenteriae Flexner VI	88-Newcastle- Manchester group		
Bacillus dysenteriae Boyd I	Type 170		
Bacillus dysenteriae Boyd II	Type P 288		
Bacillus dysenteriae Boyd III	Type D1		

The six Flexner types possess a common group antigen and separate typespecific antigens The three Boyd types are distinct antigenically from each other and from the Flexner types.

Two new Flexner types (Type 953 = provisional Type VII and Type 1296/7 = provisional Type VIII) have been described by Francis (Jour Path and Bact., 58, 1946, 320) as this section goes to press. Also see Boyd (ibid., 297)

Table 2 -Subclassification of Bacillus dysenteriae Flexner VI (including the Newcastle bacillus)

	Lactose	Glucose	Mannitol	Dulcttol	Sucrose	Indole
Type 88 (33 per- cent of strains)		A	A	_	-	-
Type 88 (66 per cent of strains)	-	A	A	(late) A	_	-
Manchester ba- cillus	[-	AG	AG	(late) AG		-
Newcastle bacıl- lus .	_	AG	-	(late) AG		-

Source: From feces in cases of dyseatery.

Habitat: A cause of dysentery in man. A cause of summer diarrhoea in children.

Note: The term Bacillus paraduses. teriae is used by Kruse (Münch, med. Wchnschr., 1917, 1309) for the Escherichia coli-like motile and gas-forming Gram-negative rods that have been found to cause dysentery-like diseases. Kruse (Deut. med. Wchnschr., 27, 1901, 388) uses the term pseudodysentery for the group that includes the Flewer. Strong, and Hiss and Russell types See Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 456. Gardner (Med. Res. Council, System of Bacteriology, 4, 1929, 170) states that "Kruse's terms B, dysenteriae for Shiga, and Bacillus pseudodusenteriae for the Flexner-Sonne-Schmitz groups have, however, never taken root outside the Germanspeaking world".

4a. Shigella paradysenteriae (Type Newcastle). (Clayton and Warren, Jour. Hyg., 28, 1929, 355 and 29, 1929, 191; Bacillus dysenteriae Flexner VI in part, Boyd, Trans. Roy. Soc. Trop Med. and Hyg., 83, 1940, 553.)

Rods: Non-motile. Gram-negative In peptone water solution, lactose, mannitol, and sucrose not fermented Glucose, maltose and dulcitol fermented

Peculiarities of the organism are: (1) Occasionally a slight bubble of gas is produced from glucose and dulcitol, (2) when the substrate is dissolved in beel extract broth, glucose, dulcitol and maltose are always fermented to gas and acid.

Does not reduce trimethylamine oxide (Wood et al., Jour. Bact., 46, 1913, 106). Optimum temperature 37°C. Does not grow at 45.5°C (Stuart et al., Jour. Bact., 46, 1943, 105).

Aerobic, facultative. Serologically related to the mannitolfermenting strains of Shigella paradysen. letrae.

Source: Isolated in 1925 from a case of diarrhoea in Newcastle-on-Tyne, England.

Habitat: A cause of human dysentery.

4b. Shigella paradysenteriae (Type Manchester). (Downie, Wade Young, Jour. Hyg., 33, 1933, 196; Bacillus dysenteriae Flexner VI in part, Boyd, Trans. Roy. Soc. Trop. Med. and Hyg., 33, 1940, 553,)

Characters as for Type Newcastle except that acid and gas are produced from mannitol. Does not produce gas from maltose.

Serologically related to the non-mannitol-fermenting strains of Shigella paradysenteriae.

Source · Five strains were isolated from cases of dysentery at Denton near Manchester, England. One strain came from a case of dysentery in Nigeria.

Habitat. A cause of human dysentery.

5 Shigella alkalescens (Andrewes) (Bacillus alkalescens Andrewes, The Lancet, London, 194, 1918, 560; Bacterium alkalescens Levine, Jour-Inf. Dis., 27, 1920, 31; Eberthella allalescens Bergey et al., Manual, 1st ed., 1923, 231; Weldin, Iowa State College Jour. Sci., 1, 1927, 179; Proshigella alkalescens Borman, Stuart and Wheeler, Jour. Bact , 48, 1944, 363 ) From the chemical term, alkaline.

Rods: 0 5 by 1 0 to 1.5 microns, occurring singly and in pairs. Non-motile.

Gelatin stab: No liquefaction.

Agar slant: Abundant, transparent, often iridescent growth.

Broth: Turbid

Gram-negative.

Litmus milk: Acid, then alkaline Potato: Moderate, grayish growth.

Indole is formed

Acid but no gas from glucose, valose, rhamnose, maltose, mannitol and dulcitol Sucrose is fermented by some strains Does not attack factore, dextrin or salicin

Reduces trimethylamine oxide to tri-

methylamine (Wood et al., Jour. Bact . 46, 1943, 106). In contrast to all other species of the genus, will also produce trimethylamine from choline (Wood and Keeping, Jour. Bact., 47, 1944, 309).

Aerobic facultative. Optimum temperature 37°C. Grows

at 455°C (Eijkman's reaction, Stuart et al., Jour. Bact., 46, 1943, 105). Not pathogenic. Not agglutinated

by Shiga immune serum. Source: From feces in cases of dysen-

Habitat: Intestinal canal.

6. Shigella pfaffii (Hadley et al.) Weldin. (Bacillus der kanarienvögelseuche. Pfaff, Cent. f Bakt., I Abt., Orig., 38, 1905, 276; Bacterium pfaffi Hadley, Elkins and Caldwell, Rhode Island Agr. Exp. Sta. Bull. 174, 1918, 169; Bacillus pfaffi Hadley, Elkins and Caldwell, ibid., 201; Eberthella pfaffi Bergey et al., Manual, 1st ed., 1923, 232; Weldin, Iowa State College Jour. Sci., 1, 1927, 180.) Named for Dr Franz Pfaff of Prague who isolated this species.

Description largely from Hadley et al. (loc. cit., 180).

Rods: 0 5 by 1 0 to 2 0 microns, occurring singly. Non-motile. Gram-negative. Gelatin colonies · Small, gravish, trans-

lucent. Gelatin stab: No liquefaction.

Agar colonies: Small, yellowish-gray, homogeneous, translucent, entire. No odor.

Agar slant: Slight, yellowish-gray, translucent streak.

Broth: Turbid, with flocculent sediment (Pfaff, loc. cit., 200).

Litmus milk: Unchanged

Potato: Moderate, whitish streak. Acid but no gas from glucose, fructose, arabinose, xylose, maltose, dextrin,

salicin and mannitol. Does not attack lactore, sucrose, raffinose, inulin, adonitol or dulcitol Indole not formed

No hydrogen sulfide produced.

that this species should be placed in the genus Actinobacillus.

Distinctive characters: Differentiation from Shigella sonner is made on cultural and morphological grounds and immediate fermentation of lactose.

Source: Isolated from cases of jointill in foals.

Habitat: Causes joint-ill in feals.

9. Shigelia ceylonensis (Castellani) Weldin. (Bacillus ceylonensis B, Castellani, Jour. Hyg., 7, 1907, 1; Bacillus dispar (in part) Andrewes, Lancet, 1. 1918, 500 (see Shigella madampensis and Shigella sonnei. Andrewes included in Bacillus dispar all lactose-fermenting members of the dysentery group); Lankordes ceulonensis B. Costellani and Chalmers, Man, Trop. Med., 3rd ed., 1919, 938; Eberthella dispar Bergey et al., Manual, 1st ed., 1923, 232 (see Shigella madampensis); Weldin, Iowa Sta Coll. Jour. Sci., 1, 1927, 182; Castallanus castellanı Cerruti, Jour Trop Med. and Hyg., \$3, 1930, 207.) Latinized, pertaining to Cevlon.

Rods. Non-motile Gram-negative, Morphology and colony characters indistinguishable from those of Shigella dysenteriac

Gelatin not liquefied

Litmus milk: Acid with coagulation. Indole is formed

Acid, but no gas, from lactose, glucose, fructose, sucrose, mannitol, dulcitol, maltose xylose, arabinose, rhamnose, sorbitol, raffinose, dextrin and glycerol. Inulin, mositol, adonited and salicin not fermented (salicin differentiates Shigella ceylonensis from Bacterium coli anaerogenes Lembke, Arch. f Hyg, 26, 1896, 299)

Substances other than the monosaccharides are characteristically fermented slowly.

Reduces trimethylamine oxide to trimethylamine (Wood et al., Jour. Bact, 46, 1943, 106).

Pathogenic for guinea pigs and rabbits Serologically the organism is stated by Castellani to be homogeneous and completely different from Shigella mal. ampensis and Shigella sonnei. The rela tions to other members of the dysenien group have not been stated

Optimum temperature 37°C. Gross at 45.5°C (Stuart et al., Jour. Bact, & 1943, 105).

Source: Isolated from the stools and intestines of persons suffering from dysentery.

Habitat: A cause of dysentery in man

 Shigella madampensis (Castellani) Weldin, (Bacillus madampensis Cas tellani, Cent. f. Bakt., I Abt., Orig, 65, 1912, 262: Bacillus dispar (in part) An drewes, Lancet, 1, 1918, 560 (see Shigella ceulonensis and Shigella sonnes), Lankordes madampensis Castellani and Chalmers, Man. Trop. Med., 3rd ed , 1919, 938; Bacterium dispar Levine, Abst Bact., 4, 1920, 15; Eberthella disput Bergey et al., Manual, 1st ed., 1923, 232 (see Shigella ceylonensis); Weldin, lows Sta. Coll. Jour. Sci , 1, 1927, 181a; Shgella dispar Bergey et al., Manual, 3rd ed., 1930, 364; Proshigella dispar Borman, Stuart and Wheeler, Jour. Bact., 43, 1944, 363)

Neter (Bact. Rev., 6, 1942, 26) com bines Shigella ceylonensis and S. malam pensis into a single species which he names Shigella castellanii

Strains currently existing in vanous

pensis (Glynn and Starkey, Jour. part., 57, 1939, 315).

Rods: Non-motile. Gram-negative. Morphology and colony charactersiadistinguishable from those of Shigella dusenteriae.

Gelatin not liquefied.

Indole is formed.

Litmus milk. Acid with coagulation Acid, but no gas, from lactose, maltose, sucrose, arabinose, vylose, glycerel, mannitol, rhamnose, glucose, fructose, galactose and deatrin. Dulcitol, salieia, inulin, inositol and adonitol not fermented.

Substances other than monosacchardes are characteristically fermented slowly.

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Reduces trimethylamine oxide to trimethylamine (Wood et al , Jour. Bact ,

46, 1943, 106). Serologically the organism is stated by Castellani to be homogeneous and completely different from Shigella ceytonensis and Shigella sonner. According to Andrewes (loc. cit.). Bacillus dispar is serologically distinct from Shigella alkalescens and Shinella paradysenteriac Fifteen strains (Glynn and Starkey, loc cit ) from various sources, labelled Bacillus dispar and conforming to the above description, proved to be sero-

logically heterogeneous. Optimum temperature 37°C. Grows at 45 5°C (Stuart et al., Jour, Bact., 46,

1943, 105), Source. Isolated from human stools and intestines

Habitat: Considered by Castellani to be a cause of colitis and cystitis

11. Shigella septicaemiae (Bergey et al ) Bergey et al. (Bacillus septicaem sac anserum ezsudatirae Riemer. Cent Bakt , I Abt , Orig., 37, 1901, 648, Eberthella septicaemiae Bergey et al., Manual, 2nd ed 1925, 250, Bergey et al , Manual, 3rd ed , 1930, 358.) Latinized, of septicemia.

Small rods: 0 5 by 1 5 to 2.0 microns, occurring singly, in pairs and in threads Motile, Gram-negative,

Gelatin colonies: Small, white, circular Gelatin stab: Slight, infundibuliform liquefaction, becoming complete in sev-

eral weeks. Agar colonies, Circular, transparent, smooth, homogeneous, entire.

Agar slant: Soft, grayish-white streak, slightly viscid, becoming transparent Does not grow on Endo agar

Broth Slight, uniform turbidity, with slight pellicle formation.

Litmus milk: Unchanged

Potato, No growth

Blood serum Yellowish-white streak, the medium becoming brownish and slowly liquefied.

Indole is formed after several days Slight acid and no gas from glucose. No acid from lactose

Hydrogen sulfide is formed.

Not pathogenic for white mice, guinea pigs, chickens or pigeons. Mildly pathogenic for ducks Aerobic.

Ontimum temperature 37°C.

Source: Isolated from blood, exudates and all of the internal organs of scese. Habitat. Cause of a fatal septicemia in

voung geese.

Appendix: The following species are also found in the literature. Many are incompletely described.

Bacıllus cols dysentericum Ciechanowski and Nowak (Cent. f. Bakt., I Abt., Orig., 23, 1898, 415.) From a case of dysentery.

Bacillus dusenteriae Migula. (Bacillus of Japanese dysentery, Ogata, Cent. f. Bakt , 11, 1892, 261; Bacillus dysenteriae liquefaciens Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 281; Bacterium dysenteriae liquefaciens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 102; Migula, Syst. d Bakt., 2. 1900, 641, not Bacillus dysenteriae Shiga. Cent f Bakt , I Abt , 24, 1898, 817; not Bacillus dysenteriae Hiss and Russell. Medical News, 82, 1903, 289; not Bacillus dysenterine Strong, Jour. Amer. Med Assoc , 35, 1906, 498; not Bacillus dusen. terrae Sonne, Smith, Jour. Hyg. 21, 1921, 91) From a case of Japanese dysentery Motile Gram-positive

Bacillus dysentericus Trevisan cillus der Dysenterie, Klebs, Cent f Bakt , 2, 1887, 248, Trevisan, I generi e le specie delle Batteriacee, 1889, 11; not Basillus dusenterious Ruffer and Willmore, Brit Med Jour . 2, 1993, 862,) From feeces

Bacterium psculal sentericum Kruse, (Kruse, Deutsche med Wehnschr., 27. 1901, 370, 356; Escherichia pseu lo lysen. teriae Bergev et al., Manual, 1st ed., 1923, 198) From feces Motile,

Bactersum walefield Berger, (Jour.

Hyg., 44, 1945, 116-119.) From feces. A non-mannitol-fermenting organism of the Flexner group. Wheeler and Stuart (Jour. Bact., 51, 1946, 324) regard this as an anaerogenic paracolon.

Shigella albofaciens (Castellani) Hauduroy et al. (Bacillus albofaciens Castellani, Meetings of the Ceylon Branch of the British Medical Association, 1905; Hauduroy et al., Dict. d. Bact. Path., 1937, 482.)

Shigella arabinotarda, types A and D, Churistensen and Gowen. (Jour. Bact., 47, 1944, 171-176.) From cases of dysentery in U. S. Army in Tunisia. A lactose-negative, mannitol-negative Shigella.

Shigella bienstockti (Schroeter) Bergey et al. (Bacillus III, Bienstock, Ztschr. f. klin. Med., 8, 1884; Bacillus coprogenes parvus Flugge, Die Mikroorganismen. 2 Aufl., 1886, 269; Bacillus bienstockii Schroeter, Kryptogamen Flora Schlesien, 3, 1, 1886, 163; Bacillus parvus Trevisan, I generi e le specie delle Batteriacee, 1889, 15; not Bacillus parvus Neide, Cent. f. Bakt., II Abt., 12, 1904, 344; Bacterium coprogenes parvus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 85; Bacterium bienstockii Chester, Man. Determ Bact., 1901, 144; Eberthella bienstockii Bergey et al., Manual, 1st ed., 1923, 227; Bergey et al., Manual, 3rd ed , 1930, 360.) From feces.

Shigella douglasi (Castellani and Chalmers) Hauduroy et al. (Bacillus douglasi Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 946; Hauduroy et al., Dict. d. Bact. Path., 1937, 484.)

Shigella etousae Heller and Wilson. (Jour. Path. and Bact., 58, 1946, 98.) From dysentery outbreak in an army camp in England.

Shigella faccaloides (Castellani) Haudroy et al (Bacillus faccaloides Castellani, 1915; see Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 946; Hauduroy et al, Dict. d. Bact. Path., 1937, 488.)

Shiqella giumai (Castellani) Hauduroy et al. (Bacillus giumai Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 294; Wesenbergus giumai Castellaul at Chalmers, Man. Trop. Med., 3rd ed 1910, 940; Bacterium giumai Weldin as Levine, Abst. Bact., 7, 1923, 15, 5c monella giumai Bergey et al., Maun 1st ed., 1923, 220; Hauduroy et al Dict. d. Bact. Path., 1937, 483.)

Shigella lunarensis (Castellani) Har duroy et al. (Bacillus lunarensis Castellani, Cent. f. Bakt., I Abt., Orig. 6i 1912, 26t; Bacterium lunarensis Vicila and Levine, Abst. Bact., 7, 1923, 18 Hauduroy et al., Dict. d. Bact. Path 1937, 489.) From feees.

Shipella metadysenterica var. A, B, C and D (Castellani) Handuroy et al (Bacillus metadysentericus var. A, B, C and D, Castellani, 1904; see Castellani and Chalmers, Man. Trop. Med., 3d ed., 1919, 946; Dysenteroides metadysetericus var. A, B, C, and D, Castellani and Chalmers, Ann. Inst. Past., 54, 123, 607; Castellanus metadysentericus Sex tellani, 1930; Handuroy et al., Dict. d Bact. Path., 1937, 489.) From cases of dysentery.

Shigela negombensis (Castellani) Harduroy et al. (Bacillus negombenis Castellani, Cent. 1. Bakt., I Abt., Oris, 65, 1912, 262; Hauduroy et al., Dict d. Bact. Path., 1937, 490.)

Shigella ozygenes (Ford) Bergey et al. (Bacterium ozygenes Ford, Studies from the Royal Victoria Hospital, Montral, I, No. 5, 1903, 47; Eberthella ozygene Bergey et al., Manual, 1st ed., 1923, 23, Bergey et al., Manual, 3rd ed., 1930, 360.) From feces.

Shigella piscatora Bois and Roy. (Naturaliste Canadien, 71, 1945, 232) From the intestine of a codfish (Gadut callarias L.).

di Castellani) Hau

dt (Aste , ,65, 1912, 266; Hauduroy et al., Dict. d.

Bact. Path, 1937, 497.) From feces
Shigella tarda (Castellani) Hauduro
et al. (Bacillus tardus Castellani, 1917;
see Castellani and Chalmers, Man.

Trop. Med., 3rd ed., 1919, 954; Hauduroy et al., Diet. d. Bact. Path., 1937, 497.)

#### PAMILY XI PARVORACTERIACEAE DAIN .

(Cent. f. Bakt., II Abt., 96, 1937, 281.)

Small, motile or non-motile rods Gram-negative. Some will grow on ordinary media, but the majority either require or grow better on media containing body fluids or growth-promoting substances. Some invade living tissues. Usually do not liquefy relatin. No visible cas formed in the fermention of carbohydrates Infection in some cases may take place by penetration of organisms through mysous membranes or skin. Parasitie to nathogenic on warm-blooded animals including mon

#### Ken to the tribes of family Paryobacterlaceae.

I. Usually grow on ordinary media

A. Aerobie to facultative anserobic.

1. Show bipolar staining. Majority ferment carbohydrates.

Tribe I. Pasteurellege, p. 545.

2. Do not show hinder steining. None ferment earlicht drates. Tribe II. Brucellege, p. 560.

B. Anagrobia

Tribe III. Bacteroideae, p. 561

II. On first isolation dependent on some factor or factors contained in blood or plant tissues Aembie to ansemble Tribe IV. Hemophilene, p. 581.

### TRIBE ! DISTERBUILDE CASTELLANI AND CHALMERS.

(Man. Trop. Med., 3rd ed., 1919, 943 )

Small, motile or non-motile, ellipsoidal to elongated rods showing bipolar staining.

### Key to the genera of tribe Pasteurelleae.

I Milk not congulated.

A Causes hemorrhagie senticemia, pseudotuberculosis, tularemia or plague. I Pasteurella, p. 516, Genne

II. Milk congulated slowly and sometimes digested. A. Causes glanders or glanders-like infections.

Genus II. Malleomyces, p. 551.

III. Milk unchanged to slightly acid

A. Associated with actinomycous in cattle and in man,

Genus III. Actinobacillus, p. 536.

<sup>\*</sup> Revised b collaboration

Prof W. A I . .

Dr. Marcaret Pittman, National Institute of Health, Washington, D. C.; Prof. I. F. Huddleson, Michigan State College, East Lansing, Michigan; and others, December. 1939.

## Genus I. Pasteurella Trevisan.\*

(Octopsis Trevisan, Atti della Accad. Fisio-Medico-Statistica, Milano, Scr. 4, 5, 1835, 102; Trevisan, Rendiconti Reale Instituto Lombardo di Scienze e Lettere, 1837, 91; Coccobecillus Gamaleia, Cent. f. Bakt., 4, 1838, 167; Eucystia Enderlein, Sitther. Gesell. Naturf. Freunde, Berlin, 1917, 317.) Named for Louis Pasteur, the French scientist.

Small, Gram-negative, ellipsoidal to elongated rods showing bipolar staining by special methods; aerobic, facultative; may require low oxidation-reduction potential on primary isolation; majority ferment carbohydrates but produce only a small amount of acid; no or slight lactose fermentation; no gas production; gelatin not liquefied; milk not congulated; parasitic on man, other mammals and birds

The type species is Pasteurella multocida (Lehmann and Neumann) Rosenbusch

and Merchant.

## Key to the species of genus Pasteurella.

I. Growth on ordinary media. Growth in milk,

- A. Non-motile and non-flagellated at 18° to 26°C. No change or slight acid m milk without coagulation.
  - Indole and H<sub>2</sub>S produced. No growth in bile. Sorbitol fermented No hemolysis on blood agar.
    - Pasteurella multocida.
    - Indole not formed. Hemolysis produced on blood agar.
       Pasteurella hemolytica.
  - 3. Neither indole nor II<sub>2</sub>S produced. Growth in bile. Sorbitol not fermented No hemolysis.
    - 3. Pasteurella pestis.
- B. Motile and flagellated at 18° to 26°C. Milk alkaline. Hydrogen sulfide produced Indole not formed.
  - 4. Pasteurella pseudotuberculosis.
- II. No growth on plain agar or in liquid medium without special enrichment No growth in milk
  - 5. Pasteurella tularensis.

1. Pasteurella multoclda (Lehmann and Neumann) Rosenbusch and Merhant. (Virus der Wildseuche, Hueppe, Berlin kin. Wochnschr. 23, 1880, 797; Bactérie ovoide, Lugnières, Recueil de Méd. Vétér, 75, 1893, 836 (Bull. Soc. Centr Méd. Vétér., N. S. 69, 1898, 839); Bacillus septicaemiae haemorrhagicae Sternberg, Man. of Bact., 1893, 408; Bacterium septicaemiae hemorrhagicae Lehmann and Neumann, Bakt. Diag., 2 Aufi., 2, 1899, 194; Bacterium multoci-

dum Lehmann and Neumann, ibid., 195;

Bacillus plurisepticus and Bacterum
avicidum Kitt, in Kolle and Wassemann,
Handb. d. path. Mikroorg., 1 Auf., 2,
1903, 562; Bacillus pleurisepticus Jordan,
General Bact., 1st ed., 1908, 293; Bacillus
bipolaris septicus Hutyra, in Kolle and
Wassermann, Handb. d. path Mikroorg.
2 Aufl., 6, 1913, 67; Bacillus bipolaris
plurisepticus Hutyra, ibid.; Pasturela
septica Topley and Wilson, Princip
Bact. and Immun., 1st ed., 1, 1931, 485;

Rearranged by Mrs. Eleanore Heist Clise, New York State Experiment Stateon, Geneva, New York, in accordance with the suggestions of Mr Philip C. Harvey and Dr. Mark Welsh, Pearl River, New York, November, 1945.

Pasteurella pluriseptica Gay et al., Agents of Disease and Host Resistance, 1935, 730; Rosenbusch and Merchant, Jour Bact., 57, 1939, 85.) From Latin, billion many

The following are regarded as identical with the above but are arranged here recording to source

Pasteurella bollingers Trevisan. Olicroparasiten bei eine neue Wild- und Rinderscuche, Bollinger, Über eine neue Wilds and Rindersouche answ. Manchen. 1878: Bacterium binolare multocidum Kitt, Sitz, Gesell, Morphol, u. Physiol., München, 1, 1885, 24: Trevisan, I generi e le specie delle Batteriacee. 1889. 21: Bacillus bousepticus Kruse. in Flugge, Die Mikroorganismen, 3 Aufl. 2. 1896. 421: Racterium bavisenticus Chester, Ann. Rept, Del. Coi. Agr. Exp. Sta . 9, 1807, 81: Bacterium multocidum Lehmann and Neumann, Bakt Diag., 2 Aufl., 2, 1899, 196; La Pasteurella bovine, Lignières, Recueil de Méd. Vétér, 77. 1900. 537: Bacillus Livolaris borisepticus Hutyra, in Kolle and Wassermann, Handb d path, Mikroorg , 2 Aufl , 6, 1913, 67. Pasteurella bourseptica Holland, Jour Bact., 5, 1920, 221; Posteurella borium Hutyra, in Kolle, Kraus und Uhlenhuth, Handb. d. path Mikroorg., 3 Aufl . 6, 1927-1929, 487: Pastcurella fergrum Handurov et al . Dict. d Bact. Path , 1937, 316.) From domestic cattle and deer.

Pasteurella aucida (Gamaleia) Trevisan. (Microbe du cholera des poules, Pasteur, Compt. rend Acad Sci., Paris, 90, 1880, 239, 952 and 1030; Granules of fowl cholera, Salmon and Th Smith, U. S. Dept. Agr. Ann. Rept., 1880, 438; Micrococcus cholerae gallinarum Zopf, Die Spaltpilze, 3 Aufl , 1885, 57; Octopsis cholerae gallinarum Trevian, Atti della Accad Fisio Medico Statistica, Milano, Ser 4, 3, 1885, 102; Bacillus chelerae callinarum l'Ingge, Die Miknorganismen, 2 Aufl., 1886, 253, Bacterium cholerae gallinarum Schmeter, Kryptogamen Flora von Schlesien, 3, 1, 1886, 155; Hühnereholembneterien, Kitt, Cent. f.

Bakt., 1, 1887, 305: Pasteurella cholerae callmarum Trevisan Renderanti Reale Instituto Lombardo de Scienze e Lettere 1887. 94: Coccobacillus aricidus Gamalela, Cent. f. Bakt., 4, 1888, 167; Trevisan. I generi e le specie delle Batteriacec. 1889, 21: Bacterium aricidum Kitt, according to Chester, Man. Determ, Bact . 1901 135: Racterium chalerae Chaster idem: Bacillus arisenticus and Bacterium arisepticum Kitt, in Kolle and Wassermann, Handb, d. nath Mikroorg., 1 Auff., 2, 1903 544 not Racellus acisenticus Chester, loc. cit., 220. Pasteurella avium Kitt, loc. cit., 562: Pasteurella gallinge Besson, Practical Bacteriology, London and New York, 1913. 447: Pasteurella cholerac-vallinarum Winslow et al., Jour. Bact., 2, 1917, 561; Bacillus cholerac-pallingrum Holland. Jour. Bact., 5, 1920, 217: Pasteurella ausentica Holland, ibid., 221.) From fon la

Pasteurella cuniculteida (Flürre) Trevisan, (Septicamichaeterien, Gaffky. Mit kaiserl Gesundheitsamte, 1. 1881. 98: Bacillus cuniculicida Flüere. Die Mikmoreanismen, 2 Aufl., 1886, 251 Trevisan, I generi e le specie delle Batteriscoe, 1889, 21; Bacterium septichacmiae Schroeter, Kryptogamen Hora von Schlesien, 3, 1, 1889, 155; Bacterium cuniculicida Chester, Ann Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 80; not Bacterium cuniculicida Chester, Man. Determ Bact . 1901. 140: Bacellus coniculisenticus Kitt, in Kolle and Wassermann, Handle, d. path. Mikroorg , 1 Aufl., 2, 1903, 562; Bacterium lepisepticum Ferry and Hoskins, Jour. Lab and Clin, Med., 5, 1920. 311; Bacillus bipolaris septicus and Bacillus lepiscoticus Ford, Textb. of Bact , 1927, 591; Pasteurella lepiseptica Holland, Jour. Bact . 5, 1900, 221; Pasteurella cuniculi Schütze, Med. Itea Council, Syst. of Bact , London, 4, 192). 469; Boeterium leportsepticum Hauduroy et al , Dict. d. Bact. Path , 1937, 314.) From rabbite.

Pasteurella suilla Trevienn. (Rothhufstabehen, Leeffer, Arb. kaiserl. Ge-

sundheitsamte, 1, 1886, 51; Rothlaufbacillen, Schutz, ibid., 74; Bacillus of swine plague, Salmon, Rept. U. S. Dept. Agr., Bur. An. Ind., 1886, 87; Bacillus parvus ovatus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 273; Trevisan, Reale Instituto Lombardo d. Sci. e Let. Rend., Ser. 2, 20, 1887, 94; Bacterium suicida Migula, in Engler and Prantl, Naturl. Pflanzenfam., 1, Ia, 1895, 27; Bacillus suisepticus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 419; Bacterium suisepticus Chester, Ann. Rent. Del. Col. Agr. Exp. Sta., 9, 1897, 80; La Pasteurella porcine, Lignières, Recueil de Méd. Vétér., 77, 1900, 391; Pasteurella suiseptica Holland, Jour. Bact., 5, 1920, 220; Pasteurella suum Hutyra, in Kolle, Kraus and Uhlenhuth, Handb. d. path. Mikroorg., 3 Aufl., 6, 1927-1929, 487.) From swine.

Bacterium boricida Migula. (Microbo del barbone dei bufali, Oreste Armanni, Atti. d. R. Istit. d'incornge, alle scienze natur. ecenom. e technol., 1887; Letta nella tornata Accad, Sept. 16, 1886; Cent. f. Bakt., 2, 1887, 60; Atti della Commissione per le malattie degli animalı, 121, 1887; Migula, Syst. d. Bakt., 2, 1900, 366; Pasteurella bubalseptica Kelser, Man. Vet. Bact., 1st ed., 1927, 195; Bacillus bubalsepticus Kelser, ibid.; Bacillus bipolaris bubalsepticus Hauduroy et al, Dict. d. Bact. Path., 1937, 312.) From buffaloses

Pasteurella vituliseptica (Kitt) Ford. (Bacilius vitulisepticus Kitt, in Kolle and Wassermann, Handb. d. path. Mi-kroorg., 1 Aufl. g. 1903, 502; Bacterum vitulitepticum Lehmann and Neumann, Bakt. Ding, 5 Aufl., g. 1912, 282; Ford, Tevtb. of Bact., 1927, 597.) From calves.

Pasieurella muricida Meyer and Batchelder. (Meyer and Batchelder, Jour. Inf. Dis., 39, 1926, 386; Pasieurella muriseptica Topley and Wilson, Princip. Bact. and Immun., 1st ed., 1, 1931, 482; not Pasieurella muriseptica Bergoy et al., 1st ed., 1923, 265 (Bacillus murisepticus Flügge, Die Mikroorganismen, 2 Aufl., 1886, '250; Erysipelothrix muriseptica Bergey et al., Manual, 2nd ed., 1925, 380).) From wild rats.

Bacillus bipolaris der malignen Meerschweinchen-Phlegmasie of Heymannand Kyriasides, Ztechr. f. Hyg., 114, 1932, 119 (Klebsiella cariae Hauduroy et al., Dict. d. Bact. Path., 1937, 261) is stated by the original authors to be closely related to this organism.

Plasaj and Pribram (Cent. f. Bakt, I Abt., Orig., 87, 1921, 1) also present a classification of the hemorrhagic septicemia bacteria.

Description from Schutze (Med. Res. Council, Syst. of Bact., London, 4, 1929, 451) who prepared it from studies of 200 strains described by 17 authors during the years 1903-1926.

Short ellipsoidal rods: 03 to 1.25 microns in length, occurring singly, in pairs, rarely in chains. Show bipolar staining. Non-motile. Gram-negative.

Gelatin: No liquefaction.

Agar: Fine translucent growth. Char-

acteristic odor. . Broth: Uniform turbidity. Charac-

teristic odor. Milk: No change in reaction. No

coagulation.
Potato: No visible growth.

Potato: No visible growth

Nitrites are produced from mirates.

Hydrogen sulfide is produced. No hemolysis on blood agar.

Acid but no gas from glucose, mannitol (usually), sucrose, fructose, sorbitol,

m lac-

dalin, maltose (usually), rafinose, rhamnose, adonitol, deatrin, inula, glycerol, salicin (usually) or erythritol. Optimum temperature 37°C. Killed

at temperatures above 45°C
Acrobe to facultative anaerobe.

Acrose to facultative the save been found on the basis of agglutination tests (Little and Lyon, Amer. Jour. Vet. Res., 1943, 110).

Virulent for laboratory animals, especially mice and rabbits.

Distinctive characters: Grows on ordinary media. Bile salts inhibit growth. Source: From numerous domestic animals and fowls, including cat, dog, cattle, horse, goat, sheep, pig, rabbit, chicken, and from reindere, buffalo, rat, etc.

Habitat: The cause of hemorrhagic septicemia in birds and mammals.

 Pasteurella hemolytica Newsom and Cross. (Jour. Amer. Vet. Med Assoc., 80 (N.S. 35), 1932, 715.) From M. L., hemolytic.

Bipolar staining.

Blood agar: Hemolysis, Indole not formed.

Acid from devtrin, fructore, galactose, glucose, glucose, glucose, glucose, glucose, insistel, lactose (usually), maltose, manntol, farfinose, sorbitol, sucrose and xylose No acid from arabinose, dulctol, inulin, mannose, rhampose or salicin.

No cross-agglutination between Pas-

Avirulent for rabbits. Source. Twenty strains isolated from

pneumonia in sheep and cattle.

Habitat: Occurs in pneumonia of sheep
and cattle.

3 Pasteurella pestis (Lehmann and Neumann) Holland. (Bacille de la peste, Yersin, Ann. Inst. Past., 8, 1891, 666; Pest Bacillus, Aoyama, Ztschr, f. Hyg., 21, 1895, 165; Bacterium vestis Lehmann and Neumann, Bakt. Disg , I Aufl., 2, 1896, 191; Bacillus pestis bubonicae Kruse, in Flagge, Die Mikroorganismen. 3 Aufl , 2, 1896, 429; Bacterium pestis bubonicae Chester, Ann Rept. Del. Col Agr Exp. Sta., 9, 1897, 81; Bacellus pestis Migula, Syst. d. Bakt., 2, 1900, 749. Eucustia pestis Enderlein, Sitzber. Gesell Naturf, Freunde, Berlin, 1917. 317, Holland, Jour. Bact., 5, 1920, 219, Coccobacillus persini Neveu-Lemaire, Proces Parasitol, Hum. 5th ed., 1921. 20 ) From Latin pestis, plague.

Rods: 10 by 20 micross, occurring

singly. Non-motile. Polar staining. Characteristic bladder, safety-pin and ring involution forms. Gram-negative. Gelatin colonies: Flat, gray, with

granular margin. Gelatin stab: Flat surface growth.

Arborescent growth in stab. No liquefaction.

Agar colonies: Grayish-abite, translucent, irridescent, undulate.

Agar slant: Growth grayish, viscid, thin, moist, translucent. Growth slow, favored by the addition of blood or sodium sulfite.

Broth: Turbid or clear with flocculi in the fluid. Old cultures show a pelluide with streamers into the fluid (stalactites). Becomes alkaline more slouly than Pasteurella pseudotuberculosis. See Bessonowa and Lenskaja, Cent. f. Bakt, I Abt., Orie. 119, 1930, 430.

Litmus milk: Slightly acid or unchanged. No congulation.

Potato. Scanty, grayish growth.

Indole not formed.

Lactose and rhamnose not attacked. Variable action on plycerol.

Nitrites are produced from nitrates. Temperature relations: Optimum 25° to 30°C, Minimum 0°C, Maximum 43° to 45°C.

Aerobic, facultative.

Source · Bubocs, blood, pleural effusion, spleen and liver of infected rodents and man. Sputum in pneumonie plague, Infected fleas.

Habitat: The causative organism of plague in man, rats, ground squirrels and other rodents. Infectious for mice, guinca pigs and rabbits. Transmitted from rat to rat and from rat to man by the infected rat frea.

Norz: Pasteurella pestis and Pasteurella pseudotuberculesis are not definitely distinguislable by serological methods (Schüter, Med Res. Council, Syst. of Fact., London, 4, 1929, 478, and Wu Lien-tch, in Chun, Pollitree and Wu, "Plague," National Quarantine Service, Sharghai, (303). Malachite given broth slowly decolorised by Pasteurella pestis and Chalmers (Man. Trop. Med., 3rd ed., 1919, 941). The organism described by Tretrop clearly was not the same as that in the culture sent by Binot of the Pasteur Institute to MacConkey and described by him (loc. cit.) as a member of the coliform group. Because of Mac-Conkey's studies, the Binot culture has been accepted as determining the nature of Bacillus coscoroba in many subsequent studies of the coliform group, e.g., Bergey and Dechan, Jour. Med. Res., 19, 1908, 182: Levine, Amer. Jour. Pub. Health, 7, 1917, 785; Winslow, Kligler and Rothberg, Jour. Bact., 4, 1919, 485; Bergey et al., Manual, 1st ed., 1923, 204; etc.

Bacillus cuniculicida Migula. (Bacillus der Kaninchenseptikämie, Eberth
and Mandry, Arch. f. path. Anat., 121,
1890; Bacillus cuniculicida mobilis Kruse,
in Flugge, Die Mikroorganismen, 3
Auft., 2, 1890; 406, Bacterium cuniculicida
mobilis Chester, Ann. Rept Del. Col.
Agr. Exp. Sta., 9, 1897, 132; Migula,
Syst. d. Bakt., 2, 1900, 751, not Bacillus
cuniculicida Flugge, Die Mikroorganismen, 2 Auft., 1880, 251.) From peritoneal exudate of a rabbit.

Bacillus mustelaccida Trevisan. (Bacillus der Frettchenseuche, Eberth auf Schimmelbusch, Fortschr d Med, 6, 1883, 295; also see Arch. f path. Anat., 115, 1889, 282; Trevisan, I generi e le specie delle Batteriaree, 1889, 13; Pasteurella mustelaccida DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 3; RSS, 996; Bacillus mustelac septicus Krusc, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 495; Bacterum mustelac septicus Chester, Ann Rept. Del Col Agr. Exp. Sta. 9, 1897, 138; Bacillus mustelac Migula, Syst d Bakt., 2, 1909, vand 756.) From a discase of ferrets

Batterium anatis Migula (Battéries du choléra des canards, Cornil and Toupet, Compt. rend Acad. Sei. Paris, 106,
1883, 1747; Bacillus cholerae analum
Kruse, in Flugge, Die Mikroorganismen,
3 Aufl. 2, 1896, 417; Migula, Syst. d.
Bakt., 2, 1900, 304.) Regarded as the
cause of duck cholera and very similar

to, if not identical with, Pasteurella aricida. See Rettger and Scoville, Jour. Inf. Dis., 20, 1920, 220. From the blood and other organs of infected ducks.

Bacterium cuniculi Migula. (Bacillus der Brustseuche des Kaninchens, Beck, Etschr. f. Hyg., 15, 1893, 363; Bacillus cuniculi meumonicus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 418; Bacterium cuniculi pneumonicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 84; Migula, Syst. d. Bakt., 2, 1900, 370; Bacterium beckii Chester, Man. Determ. Bact., 1901, 142) Associated with a lung plague of rabbits.

Baterium haemornhagicum (Kruse) Lehmann and Neumann. (Kolb, Arts. Auiserl. Gesundheitsamte, 7, 1892, 60; Bacillus haemornhagicus Kruse, in Flügge, Die Mikroorganismen, 3 Aufi., 2, 1896, 21; Lehmann and Neumann, Bakt. Diag., 1 Aufi., 2, 1896, 194.) From the nuocous membranes of ever nations.

Bacterium palumbarium Miguls. (La bactérie de la maladie des palombes, Leclainche, Ann. Inst. Past., & 1894, 493; Bacillus cholerae columbarum Kruze, in Flugge, Die Mikroorganismen, 3 Auf., 1896, 417; Bacterium cholerae columbarum Chester, Ann. Rept. Del. Cel. Agr. Evp. Sta., 9, 1897, 84; Migula, Syst. d. Bakt., 2, 1900, 368; Bacterium chumbarum Chester, Man. Determ. Bact., 1901, 141.) Associated with an epidemic in wild oligeous.

Bacterium phasianicida Klein, (Rhein, Cent. 1, Bakt., 1 Abt., Orig, 31, 1902, 76; Hacterium phasianidarum mebile Enders, Berl. tierartil. Wehnschr., No. 23, 1902; abst. in Cent. f. Bakt., I Abt., Ref., 34, 1904, 384) From an epidemic in pheasants (England). Hadley, Elkins and Caldwell (Rhode Island Agr. Exp Sta., Bull. 174, 1918, 28) state that this species (which they call B. phasianicida) belongs in the group of paratypholds (Salmonella).

Bacterium purpurum Chester. (Pacillus of purpura-haemorrhagica, Babes, Septiche Proz Kindesalters, Leipzig. 1889; Bacillus haemorrhagicus septirus Kruse, in Flügge, Die Mikroorgenismen, 3 Aufl., 2, 1896, 421; Bacterium haemorkagieus septicus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 85; Chester, Man. Determ. Bact., 1901, 143.) From a case of septicema in man.

Bacterium fitzonii Migula. (Bacillus der haemorrhagischen Infektion, Titzoni and Giovannin, in Zeigler, Betträge, 7, 1889, 300; Bacillus haemorrhagicus telenosus Kruse, in Flügge, Die Mikrorgnismen, 3 Aufl., 2, 1896, 425, Bacterium haemorrhagicus telenosus Chester, Ann Rept. Del. Col. Agr. Exp. Sts., 9, 1897, 85; Migula, Syst. d. Bakt., 2, 1900, 386; Bacterium relenosum Chester, Man. Determ. Bact., 1901, 144.) From the blood of a child having a hemorrhagic infection.

Bacterium rassalei Migula (Tirron and Giovannini, in Zeigler, Betträge, 7. 1870; Bacillus harmorrhagueus nephrituda Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. g., 1896, 421; Bacterium haemorrhagieus nephritudas Chester, Ann Rept Del. Col. Agr. Exp. Sta., g., 1897, 85. Migula, Syst. d. Bakt, g., 1900, 387, Bacterium nephritidas Chester, Man Determ. Bact., 1901, 185 | Solated by Vassale from a case of hemorrhague nephritus

Pasteurella bouffards Commes (Commes, 1919; quoted from Neveu-Lemaire, Précis de Parasitol. Hum, 5th ed., 1921, 21.) The cause of a human prateurellosis observed by Bouffard at Ramako in 1909.

Pasteurella caniseptica Hauduroy et al (Pasteurella du chien, Lignières, Recueil de Méd. VCt., 77, 1900, 409, Bacterium canicida Lehmann and Neumann, Bakt Drig. 4 Aufl. £, 1907, 277, Hauduroy et al, Diet. d. Bret. Path., 1937, 312.) From dogs.

Pasteurella capraseptica (Lanfranchi and Pacchoni) Hauduroy et al (Bacillus pacumonue caprae Nicolle and Refisley, Ann. Inst Past, 10, 1950, 221, Pasteurella du chevre, Liganires, Recueil de Méd. Véter, 17, 1990, 536, Bacillus caprasepticu Lanfranchi and Pacchoni, 1926; Bacillus bipolaris caprisepticus Chefik Kolayi and Raif, 1935; Hauduroy et al., Dict. d. Bact. Path., 1937, 313.) From hemorrhagic septicemia in goats. Pasteurella cariae Hauduroy et al. (Gaté and Billa, Compt. rend. Soc. Biol., Paris. 99, 1928, 814; Hauduroy et el.

(Gaté and Billa, Compt. rend. Soc. Biol., Paris, 99, 1928, 814; Hauduroy et el., Diet. d. Baet. Path., 1937, 313) From a guinea pig with a tuberculosis-like disease.

Pasteurella cariseptea (Schwer) Haudeury et al (Pasteurella du cobaye, Phisalix, Compt. rend. Soc Biol., Paris, I. 1893, 761, Bacterium carisepticum Schwer, Cent. F. Bakt., I Att, Orig., 53, 1902, 47; Hauduroy et al., Diet. d. Bact. Path., 1937, 314.) From hemorrhagie septiecima in guines pigs.

Pasteurella desmodilli Pirio (Pub So African Inst. Med Res , 4, 1929, 191)

Pasteurella equieptica Kelser. (Bacille de la septicémie hémorragique du cheval, Lignières, Bull. Soc Centr. d Méd. Vét. 15, 1897, 437 and 19, 1895, 819; La Pasteurella equine, Lignières, Recueil de Méd Vét. 77, 1900, 521; Kelser, Man. Vet Bact, 1st ed., 1927, 191; Bacillus equiespiricus Kelser, bind., Dacillus pintumonae com Docts ) Trom hores.

Pasteurilla felis (Migula) Hauduroy et al (Bacillus solirarus septicus files Fooca, Ann d Instit. d'igrene d. Univ. di Roma, 2, 1822 and Cent. 1 Blatt, 17, 1892, 406, 1822 and Cent. 1 Blatt, 17, 1892, 406, 1822 and Cent. 1 Blatt, 17, 1892, 407, 1892 and 18, 2, 1892, 6, 425; Bacterus felis septicus Chester, Ann. Rept. Del Col. Arr. Exp. Sta. 9, 1897, 81, Pasteurilla du chat, Liganères, Recuent de Méd. Vét., 27, 1890, 433, Bacterura felis Migula, Syst. de Bakt. 2, 1903, 375, Hauduroy et al, Diet d Bact. Path., 1937, 316) From the sputum of a cat.

Patteurila matthis (Miesaner, and Schoop) Hauduroy et al. (Silbehenlakterium, Danmann and Freese, Deut. terárit! Wehnschr, 15, 1907, 165, Bipolar organism of the Pasteurila group, Leyshon, Vet. Jour., 83, 1929, 229, Batterium matitidis Miesener and Schoop, Deut. terfarit! Wehnschr, 40, 1932, 69; Pasteurella, Marsh, Jour. Amer. Vet. Med. Assoc., 81 (N.S. 34), 1932, 376; Bacterium ovinum Haupt, Cent. f. Bakt., I Abt., Orig., 128, 1932, 365; Hauduroy et al., Dict. d. Bact. Path., 1937, 316.) The cause of infectious mastitis of eves.

Pasteurella necrophora Hauduroy et al. (Bacillo de la nécrose infectieuse des Canaris, Cornell, The Vet. Record, 84, 1928, 350; Hauduroy et al., Diet. d. Bact. Path., 1937, 318.) From domestic canaries.

Pasteurella eviseptica Hauduroy et al (Galtier, Jour. d. méd. vét. et d. 200t., 1893-1890, 58, 113 and 481; La Pasteurella evine, Lignières, Recueil de Méd. Vétér., 77, 1900, 529; Bacillus bipolaris evisepticus Hutyra, in Kolle and Wassermann, Hand. d. path. Mikro-

org., 2 Aufl., 6, 1913, 67; Hauduroy et al., Dict. d. Bact. Path., 1937, 319.) From sheep.

Pasteurella pericardits Hauduroy et al. (Bacterium cavarum pericardits Roth, Acta Pathol. et Microb. Scand, 11, 1934, 335; Hauduroy et al., Dict. d. Bact. Path., 1937, 319.) From guinea pigs.

Pasteurella strasburgensis Hauduroy et al. (Coccobacille de Strasburg, Debre, Compt. rend. Soc. Biol., Paris, 82, 1019, 224; Hauduroy et al., Diet. d. Bact. Path., 1937, 323.) From a case of purulent pleurisy.

of pointent pennsy.

Pfeifferdla analipeatifer Hendrickson and Hilbert. (Hendrickson and Hilbert, The Cornell Veterinarian, 22, 1932, 239; Hemophilus analipeatifer Hauduroy et al., Diet. d. Bact. Path., 1937, 247. From a septicemic disease of ducks.

### Genus II. Malleomyces Pribram.\*

(Cladascus Enderlein (in part), Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 316, Pfeifferella Buchanan, Jour. Bact., 8, 1918, 64; Pribram, Klassification der Schizomyceten, Leipzig, 1933, 11 and 93; Loefflerella Gay et al., Agents of Discase and Host Resistance, Indianapolis, 1935, 782.) From Latin malleus, glanders and suyces, fungus.

Because Pfeifferella was proposed inadvertently (Buchanan, Gen. Syst. Bact., 1925, 420) and because of a general feeling that it is inappropriate, Malleomyces Pribram is used as the earliest suitable name for this genus. The indefinite description of a organism (Malleomyces equestris) by Hallier (Ztschr. f. Parasitenkunde, 1870, 119) as the cause of glanders has not previously caused confusion and need not do so in the future.

Short rods, with rounded ends, sometimes forming threads and showing a tendency toward branching. Mottle or non-motile. Gram-negative. Tendency to bipolar staining. Milk slowly coagulated. Gelatin may be liquefied. Specialized for parasitic life. Grow well on blood serum and other body fluid media.

The type species is Malleomyces mallei (Flugge) Pribram.

# Key to the species of genus Malleomyces.

- Carbohydrates not fermented. Honey-like colonies on potato. Glycerol agar colonies slimy or tenacious, translucent. Non-motile.
  - 1. Malleomyces mallei.
- II. Carbohydrates fermented. Profuse, creamy growth on potato. Glycerol agar colonies indescent, becoming corrugated Motile.
  2. Malleemuces pseudomallei.
  - 2. Matteomyces pseudomatics

Revised by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, December, 1938; further revision, December, 1945.

Malleomyces mallel (Zonf) Pri-Motanila Löffler and Schütz Doutsche med Wehnsehr No. 52 1882 Bacillus maller Zonf. Die Spaltpilze. 3 Auft 1885 80 Rotzbaeillus, Loffler Arb. kaiserl. Gesundheitsamte. 1, 1886. 222: Racterium malles Migula, in Engler and Prantl. Die natürl Pflanzenfam . 1. 1a. 1895, 21: Corunebactersum malles Lehmann and Neumann Bakt Ding. 2 Aufl., 2, 1899, 366; Mucobacterium mallei Chester, Man. Determ Bact . 1901. 353: Cladascus mallei Enderlein, Sitzber Gesell, Naturf, Freunde Berlin, 1917. 395, Pfeifferella mallei Buchanan, Jour Bact., 3, 1918, 54: Selerothrix maller Vuillemin, Encyclopédie Mycolog, Paris, 2. Champignons Parasites, 1931, 135. Brucella mallei Pacheco, Revista da Sociedado naulista de Medicina veterinaria, 3, 1933, 1: Aetinobacillus maller Thompson, Jour. Bact . 26, 1933, 226, also Jour. Bact., 25, 1933, 41, Pribram. Klassification der Schuzomyceten Leipzig and Vienna, 1933, 93; Loefflerella maller Gay et al., Agents of Disease and Host Resistance, Indianapolis, 1935, 782.) From Latin malleus, glanders, a disease of horses.

Bacillus ozenae Trevisan (Corr Ser., 1881, n. 222) is identical with this species according to Trevisan (I generic le specie delle Batteriacce, 1889, 13)

Description largely from Kelser, Man Vet. Bact., 2nd ed., 1933, 325

Slender rods: 0.5 to 10 by 20 to 50 microns, with rounded ends, usually occurring singly, in pears and in groups, but may grow into filaments. Branching involution forms on glycerol sgr. Show irregular staming grommon. Non-motile Gram negative.

Gelatin Poor growth. Usually no liquefaction. May be slowly liquefied (Jordan, General Bact, 11th ed., 1935, 491).

Agar colonies. Moist, grayish white layer, translucent, ropy, with regular borders. Later become yellowish or yellowish-hown. Agar slants: Glistening, moist, ropy, gravish-white growth.

Löffler's scrum: Good growth. Moist, viscid, yellowish colonies develop after 36 to 48 hours.

Broth. Turbid, sometimes with thin pellule. Slimy or may sediment.

Litmus milk: Coagulation usually occurs after a week with some acid production. Litmus may or may not be

Potato. After 36 to 48 hours, pale yellow, hency-drop-like colonnes. Later becoming darker, reddish-yellow or chocolate color. The medium sometimes has a faint greenish tinge around the growth. Indde not formed.

Nitrites not produced from nitrates Carbohydrates usually not fermented Some strains produce small amounts of acid from clucose.

Optimum temperature 37°C No growth below 20°C or above 44°C.

terobic, facultative anserobic.

Distinctive characters Culture media of slightly and reaction best suited for growth, addition of glycerol favors growth, honey-like growth on potato.

Source Isolated by Löffler and Schütz from the liver and spleen of a horse. Lesions in snimals and man.

Habitat The cause of glanders, affecting horses, man, sheep and goats. Transmissible to dogs, cats, rabbits and guines ness

2 Malleomyces pseudomallei (Whitmore) Breed. (Bacillus preudomallei Whitmore, Jour Ilyg, 13, 1913, 1, Bacillus whitmore Stanton and Fletcher, Trans 1th Cong Far Irak Arsn. Trop. Med. 2, 1921, 196, also Jour. Ilyg, 43, 1923, 317, Pfeifferella pseudomallei Tord,

Vuillemin, Encyclopédie Mycolog., f., Champignons Parasites, 1931, 126; Actinobacillus pseudorallei Thompson, Jour. Ract., 85, 1933, 220; also Jour. Hact.,

color.

Aerobic, facultative.

Distinctive character: Manner of growth in liquid gelatin.

Source: Found in lesions of actinomycosis.

Habitat . Presumably in actinomycotic lesions

3. Actinobacillus actinoides (Smith) Topley and Wilson. (Bacillus actinoides Th. Smith, Jour. Exp. Med., 28, 1988, 333; Actinomyces actinoides Bergey et al., Manual, 1st ed., 1923, 346; Topley and Wilson, Princip. of Bact. and Immun., 1st ed., I, 1931, 256.) From Greek, ray-like.

Slender rods in tissues. In cultures may be bacillary or coccoid in form. Grows only under increased CO<sub>2</sub> tension (so-called microacrophilic). Does not grow on ordinary agar or broth, except occasionally when transferred from more favorable media. Most characteristic growth on coagulated blood serum.

Gelatin: No growth.

Agar colonies Very minute, pale, straw

Agar slant: Best growth seen in water of condensation. Serial transfers on this medium generally fail.

Broth: No growth.

Litmus milk: No growth.

Potato: No growth.

Coagulated blood serum (cow): Growth appears first in the condensation water. Appear as granules, consisting of capsular material in which bacillary forms are embedded. Surface mulberry-like because of club-like extensions of espeniar material. In stained preparations, the capsular material appears amorphous

Optimum temperature 37°C.

Microserophilic.

Microeropinite.

Not pathogenic for laboratory animals, except possibly the white rat in which a spontaneous chronic pneumona occurs caused by an organism indistinguishable from this one. Experiments with rats by artificial inoculation have not been reported.

Source: From lungs of calves suffering from chronic pneumonia.

Habitat: Has not been recognized in nature except in pathological processes

#### \* APPENDIX TO TRIBE PASTEURELLEAF

While the authors who describe the following new genus with its single species do not indicate its general relationships, it would appear to be as closely related to the species placed in *Pariobacteriaceae* as to those in any other family. It is therefore placed in this appendix pending a clarification of the situation.

Genus A. Donovania Anderson, De Monbreun and Goodpasture.

(Jour. Exp. Med., 81, 1945, 25.) Named for C. Donovan who first described the type species.

Picomorphic non-mottle rods, evhibiting single or bipolar condensations of chromatin. Occur singly and in clusters May be capsulated or non-nepsulated. Gram-negative. Growth outside human body occurs only in the yolk, yolk sae or anniotic fluid of developing chick embryo or in a medium containing embryonic yolk. Pathogenic for man causing ermulomatous lesions, articularly in the incuinal recion.

The type species is Donotania granulomatis Anderson, De Monbreun and Goodnasture.

1 Donovania granulomatis Anderson et al. (Epithelial cell parasites, Donovan, Indian Med. Gaz., 49, 1905, 414; Donovan bodies, Dienst, Greenblatt and Sanderson, Jour. Inf. Dis. 62, 1935, 112, Donovan organism, Anderson, Sevence, 67, 1913, 500; Anderson, De Monbreun and Goodpatture, Jour Exp. Med., 84, 1915, 25.) From M. L. granuloma, of granuloma, of

Pleomorphic rods 1 to 2 microns in length, with rounded ends, occurring singly and in clusters. Intracellular forms usually capsulated. Non-motile Gram-necutive.

No growth on ordinary culture media. Chick embryo. Grows readily in 30lk, yolk sac and feebly in amniotic fluid of developing chick embryo

Embryonie yolk medium Growth

Distinctive characters: Capsulated forms readily demonstrated by means of Wright's stain as blue tacillary bodge surrounded by well-defined dense pinkish capsules Non-capsulated forms variable in morphology. Characteristic safety-pin forms may be demonstrated

Not pathogenic for the common experimental animals.

Source Granulomatous lesions of man. Habitat: Human lesions. The cause of granuloma incumale.

<sup>\*</sup> Prepared by Dr. Orren D. Chapman, Syracuse Medical College, Syracuse, New York, March, 1946

## TRIBE II. BRUCELLEAE BERGLY, BREED AND MURRAY.

(Preprint, Manual, 5th ed., October, 1938, vi.)

Small, motile or non-motile rods or coccolds which grow on special media. There is a single genus Brucella.

### Genus I. Brucella Meyer and Shaw.\*

(Jour. Inf. Dis., 27, 1920, 173.) Named for Sir David Bruce, who first recognised the organism causing undulant lever.

Short rods with many coccoid cells, 0.5 by 0.5 to 2.0 microns; non-motile; capsulated; Gram-negative; gelatin not liquefied; neither acid nor gas from carbohydrates; urea utilized; parasitic, invading all animal tissues, producing infection of the genital orange, the mammary gland, the respiratory and intestinal tracts; pathogonic for various succies of domestic animals and man.

The type species is Brucella melitensis (Hughes) Meyer and Shaw.

#### Key to the species of genus Brucella.

- I. Non-motile.
  - A. Grow in special media containing basic fuchsin.
    - 1. Grows in media containing thionin.
    - Brucella melilensis.
       Does not grow in media containing thionin.
  - 2. Brucella abortus.

    B. Does not grow in media containing basic fuchsin.
    - Grows in media containing thionin.
      - 3. Brucella suis.
- II. Motile.

4. Brucella bronchiseptica.

Differential characters of the three closely related species of genus Brucella.

Species	Infec- tivity for guinea pigs	Re- quires COy for isa- lation	HiS forma- tion	*Glacose utilized	Amino- nitio- ren utilized	Growth in the presence of	
						Thia- nin	Basic fuchtia
		10 per	days				
Brucella melilensis Brucella abortus	++ ++ ++	0 ++ 0	±1 2 4	+++ + +++	+ ++ +	+++ 0 +++	+++

<sup>·</sup> All utilize glucose in shake cultures.

1. Brucella melitensis (Hughes) Meyer and Shaw. (Bruce, Practitioner, 39, 1887, 161, tbid., 40, 1888, 241; Rept. Army Med. Dept., London, 32, 1890, Append. No. 4, 465; streptococcus Miletensis (sic) Hughes, The Mediterrancan Naturalist, 2, February 1, 1892, 325; Micrococcus melitensis Bruce, Ann. Inst.

<sup>\*</sup> Revised by Prof. I. F. Huddleson, Michigan State College, East Lansing, Michigan, December, 1942.

Past., 7, April, 1803, 289; Hughes, Ja Riforma Med., 5, Aug or Sept, 1803, 789 and Ann. Inst. Past., 7, Aug., 1803, 630, Bacterium melitense Sasawa, Zitefir f. Hyg., 70, 1912, 181; Meyer and Shaw, Jour Inf. Dis., 27, 1923, 173, Bactilus melitensis Holland, Jour Bact., 5, 1920, 219; Alcaligenes melitensis Bergey et al., Manual, 1st ed., 1923, 233, Brucella melitensis var. melitensis Evans, U. S. Puble Health Reports, 38, 1923, 1947) From Latin. of Malta.

Short ellipsoidal rods 0 3 to 0 4 micron in length, occurring singly and in pairs, rarely in short chains Non-motile Non-acid-fast. Gram-negative

Gelatin colonies. Small, clear, entire. Gelatin stab. Slow growth No liquefaction.

Agar colonies · Small, circular, convex, amorphous, smooth, glistening, entire, bluish-green, grayish if R type

Agar slant: Growth slow, moist, honeyiske, entire. After a week, the agar 18 turned brownish and crystals may ap

Pear
Broth After 10 days, moderate turbidity and grayish sediment Reaction al-

kaline, pH 8 0 or higher.

Litmus milk · Unchanged at 24 hours

Later becomes alkaline

Potato Scant growth, grayish becoming brownish.

Indole not formed.

Nitrates reduced, often with complete disappearance of nitrite (Zobell and Meyer, Jour Inf Dis, 51, 1932, 99). Because of the latter fact, reports in the literature are apparently contradictors.

Ammonia produced from urea Growth enhanced on beef liver or

tryptose agar of pH 68 Neither acid nor gas from carbohy drate

Neither acid nor gas from carbohy drate media Ontimum reaction pH 7.4

Optimum temperature 37°C No growth at 6° or at 45°C Killed at 5°°C Aerobic

Distinctive characters dequires no increased CO<sub>2</sub> tension Source: Isolated by Bruce (1887, loc. cit.) from the spleen in fatal cases of Malta fever.

Habitat: Chief host the milch goat.

The cause of undulant fever (brucellosis) in man and abortion un goats. May infect cows and hogs and be exercted in their milk. Infectious for all domestic animals.

2. Brucella abortus (Schmidt and Weis) Meyer and Shan. (Bacillus of abortion, Bang, Ztschr. f. Thiermed., 1, 1897, 241; Bacterium abortus Schmidt and Weis, Bakterierne, 1901, 266; Bacterrum abortreum Chester, Man. Determ. Bact , 1901, 121 , Coryncbacterium abortus endemics Preiss, Cent f. Bakt., I Abt . Orig. 55, 1902, 191: Bacillus abortus Evans, Jour Wash Acad Sci., 5, 1915. 122, Meyer and Shaw, Jour. Inf. Dis, 27, 1920, 173, Alcaligence abortus Bergey et al , Manual, 1st ed , 1923, 234; Brucella melitensis var abortus Lyans, Public Health Reports, 58, 1923, 1917 ) From Latin abortus, an untimely birth.

The morphological and cultural characters are similar to those of Brucella maintens with the following everptions:
Requires 10 per cent CO<sub>2</sub> for isolution, becomes acrobic after several transfers; the browning of the medium in agar slant culture is less marked, S cultures can be differentiated from Brucella multiens;, but not from Brucella suits, by the aggitutina absorption test.

Source: From the genital organs and milk of infected cattle and from blood in human cases of undulint fever

Habitat. Chief best the milch cow. The cause of infections abortion in cattle. The same effects are produced in marre, sleep, tablata and guines pags, and all domestic animals except bogs. Caures undulant fever (brucelloss) in man

3 Brucella suls Huddleson (Organ ism resembling Bacillus abortus, Anonnous, U. S. D. A. Ann. Rept. Sees Dept., Rept. of Chief Bur. Anonal Ind., 1914, 86 (30); authorship established by Traum in North' Amer. Vet. 1, No. 2, 1920; described as Bacillus abortus by Good and Smith, Jour. Bact., 1, 1916, 415; Huddleson, Undulant Fever Symposium, Amer. Pub. Health Assoc., (Oct., 1928) 1929, 24; also Mich. Agr. Exp. Sta. Tech. Bull. 100, 1929, 12; Brucella melitensis var. suis Hardy, Jordan, Borts and Hardy, Public Health Reports, 45, 1930, 2433; Bacillus abortus suis Meyer, Amer. Jour. Pub. Health, 21, 1931, 503.) From Latin, of swine.

The morphological and cultural characters are similar to those of Brucella melitanses.

S cultures of Brucella suis can be differentiated from S cultures of Brucella melitensis, but not from S cultures of Brucella abortus, by the agglutinin absorption test.

Source: From urinogenital and many other organs of swine.

Habitat: Chief host the hog. Causes abortion in swine and undulant fever (brucellosis) in man. Also infectious for horses, dogs, cows, monkeys and laboratory animals.

The differentiation of the above species of Brucella by the bacterostate action of dyes depends upon the medium used When tryptose agar (Difco) is used, basic fuchsin and thionin should be used in a final dilution of 1:100,000

There are several forms of the R and mucoid phases of Brucella spp (Huddlesson, Amer. Jour. Vet Res. 7, 1946, 5). The true R type differs from the S type in its lack of pathogenicity, its antigenic properties, its susceptibility to agglutination by exposure of suspensions to heat and to basic dyes in concentration of 1:2000, and colonul appearance. The mucoid phases differ antigenically, morphologically and culturally Colonies on agar are spherical or flat, regular in contour, grayish to mucoid in appearance. Suspensions are not agglutinated by heat or dyes, or always by special

agglutinating serums. There is no change in their growth characteristics on media containing either basic fuchsin or thionin.

4. Brucella bronchiseptica (Ferry)
Topley and Wilson. (Ferry, Amer. Vet.
Rev., 37, 1910, 499; also see McGonan,
Jour. Path., 15, 1911, 372; Bacillus broncheams Ferry, Jour. Inf. Dis., 8, 1911,
402; Bacillus bronchisepticus Ferry,
Amer. Vet. Rev., 41, 1912, 79; Bacterium
bronchisepticus Evans, Jour. Inf. Dis.,
18, 1916, 578; Bacterium bronchicanis
Holland, Jour. Bact., 5, 1920, 221; Atcaligenes bronchisepticus Bergey et al.,
Manual, 1st ed., 1923, 231; Topley and
Wilson, Princip. Bact. and Immun.,
1st ed., 1, 1931, 598.) Latinized, disease
of the bronchial tubes.

Evans (loc. cit., 593) regards Bacterium bronchisepticus as related to Bacterium abortus morphologically, culturally, biochemically and serologically.

Short slender rods: 0.4 to 0.5 by 20 microns, usually occurring singly, sometimes in pairs and chains. Motile with 4 to 6 peritrichous flagella (Topley and Wilson). Gram-negative.

Gelatin colonies: Similar to those on

agar.

Gelatin stab: Slow filiform growth.

No liquefaction.

Agar colonies: Small, opaque, white, slightly raised, porcellaneous, entire.

Agar slant: Growth moderate but more luxuriant than in Brucella melitensis, fillorm, slightly raised, smooth, opales-

, pelliele idor de-

velops.

Litmus milk: Alkaline. No coagulation.

Potato Growth fairly abundant, brownish, glistening, moist, sticky. Medium is darkened.

Indole not formed. Nitrates often produced from nitrates

Nitrates often produced from nitrates (Topley and Wilson).

No seid or gas from glucose, sucrose, lactose, maltose or mannitol.

No H.S produced (Topley and Wilson)
Catalase positive (Topley and Wilson)
Ammonia formed from urea and asrangeme.

Optimum temperature 37°C Killed in twenty minutes at 55°C

Aerobic, facultative

Source: From dogs affected with dis-

Habitat: Causes acute, often fatal, nneumonia in dogs generally as a second ary invader in distemper. Also pathogenic for cats, rabbits, guinea pigs, ferrets, white rats and monkeys. Some times occurs in man.

Appendix: The following are recorded in the literature discussing this genus Brucella etansi Pacheco (Revista da Sociedado Paulista de Med Vet 5 1933, 9) is a name applied to a group of therteen cultures referred to by Evans (Jour. Inf. Dis., 25, 1918, 351) as abortusiske hacteria although she definitely indicates that these cultures do not agree with each other in their biochemical characteristics (loc. cit. Table 4. p. 361).

The binomals Bricella paramélitensis, Bructla parabortus and Brucella parabortus and Brucella parasus have been used for inagglutinable strains of these three species which are, necording to Topley and Wilson (Princip). Bact sud Immun, 2nd ed., 1936, 632), now known to be merely rough variants, not deserving to be so name.

Micrococcus paramelitensis Negré and Başmond (Compt. rend. Soc. Biol., Paris, 72, 1912, 791 and 1952.) Micrococcus pseudomelitensis Sergent

Micrococcus pseudomentensis bergent and Zummitt. 1938 Exact reference not known

#### TRIBE III. BACTEROIDEAE TRIB. NOV.

Motile or non-motile rods without endospores. May or may not require enriched culture media. Obligate anaerobes. Gram-negative.

Key to the genera of tribe Bacteroldeae.

I. Cells with rounded ends.

Genus I. Bacteroides, p. 564.

II. Cells with pointed ends.

Genus II. Fusobacterium, p. 581.

#### Genus I. Bacteroides Castellani and Chalmers.\*

(Man. Trop. Med., 3rd ed., 1919, 959.)

Characters as for the tribe. From Greek, like a rod.

The type species is Bacteroides fragilis (Veillon and Zuber) Castellani and Chalmers.

Nore: The descriptions have been taken largely from Weinberg et al. (Les Microbes Anaérobies, Paris, 1937, 658); Prévot (Ann. Inst. Past., 60, 1938, 283); Haudron; Ehringer, Urbain, Guillot and Magrou (Diet. Bact. Path, Paris, 1937, 51); and Eggerth and Gagnon (Jour. Bact., 25, 1933, 389). Because cultures of many of these organisms have not been subjected to critical study with identical tests and media, it is difficult to know how many should be considered as distinct species, and the present arrangement must be considered as tentative. The key, of necessity, has been drawn up from recorded characters which appeared useful for the purpose and these on further study may prove to be inadequate.

### Key to the species of genus Bacteroldes.

- Not requiring enriched media.
  - A Gas formed from proteins.
    - Hydrogen sulfide not produced.
      - a Non-motile.

Bacteroides fragilis.

na Motile.

Bacteroides serpens,

Hydrogen sulfide produced.

a Indole not formed

b. Very pleomorphic.

3. Bacteroides funduliformis.

bb. Not markedly pleomorphic.

4. Bacteroides siccus.

aa Indole formed.

Gelatin liquefied.

5. Bacteroides coagulans

<sup>\*</sup> Completely revised by Dr. T. E. Roy, Bacteriologist to the Hospital for Sick Chldren, Toronto, Ontario, Canada and Dr. C. D. Kelly, Assistant Professor of Bacteriology, McGill University, Montreal, P. Q., Canada, December, 1938, rearranged, December, 1948.

- bb. Gelatin not liquefied.
- relatin not inquence.
  c. No acid from lactose and maltose. 6. Bacteroides carius.
  - cc. Acid from lactose and maltose. d. Acid from sucrose. No seid from glycerol. 7. Bacteroides inacoualis.
    - dd No seid from sucrose. Acid from glycerol. 8 Bacteroides ensolitus.
- B. No gas formed from proteins
  - 1. Indole not formed.
    - a. Hydrogen sulfide not formed. b No send from lactose.
      - bb. Acid from lactose.
        - e. No acul from salicin

          - ee. Acid from salicin
- 9. Bacteroides rescus. 10. Bacteroides exiguus.
- 11. Bacteroides uncatus.
  - na Hydrocen sulfide formed. b. No acid from salicin e. Gelatin liquefied
- Acid from arabinose. 12. Bacleroides rulgatus.
  - 13. Bacteroides incommunis. cc. Gelatin not liquefied.
  - bb. Acid from saliein No acid from arabinose. 14. Bacteroides distasonis.
  - bbb. No acid from saliein or arabinose. 15 Bacteroides tumidus.
    - c. Acid from sorbitol 16. Bacteroides conrerus. cc. No acid from sorbitol.

  - a. No seed from selicin or arabinose 17 Bacteroides oralus 2 Indole formed
    - an Acid from salicin and arabinose.
      - b. No acid from mannitol e No acid from rhamnose.
        - ce. Acid from rhamnose d Not capsu ated
          - dd. Capsulated
        - bb. Acid from mannitol
  - Il Requiring an enriched medium.
    - A Provincing a black pigment.
    - B Not producing pigment.

- 19. Bacleroides thelaiolaomieron.
- 2). Bacteroides rarrabilis. 21. Bacteroides gulosus.

Bacteroides uniformis.

- Macteroides melaninagenicus
- 23. Racteroider carine.

1. Bacteroides fragilis (Veillon and Castellani and Chalmers. (Bacillus fragilis Veillon and Zuber, Arch. Med. Exp. et Anat. Path., 10, 1898, 870; Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 959; Fusiformis fragilis Topley and Wilson. Princip. Bact. and Immun., 1st ed., 1, 1931, 302; Ristella fragilis Prévot, Ann. Inst. Past., 60, 1938, 290.) From Latin fragilis, fragile.

Rods with rounded ends, staining more deeply at the poles, occurring singly and in pairs. Non-motile. Grame ncentive.

Gelatin: No liquefaction; small amount of gas.

Agar colonies: Small, gray, irregular. Broth: Turbid.

Indale not formed.

Hydrogen sulfide not formed.

Litmus milk: No coagulation. Slight amount of cas.

Nitrites not produced from nitrates. Acid from fructose, maltose, sucrose, galactose, glucose and arabinose. Some strains produce acid from lactose (Weinberg et al . Les Microbes Anaérobies, 1937, 720).

Apperobic.

Optimum temperature 37°C.

Pathogenicity: Some strains produce subcutaneous abscesses in rabbits, guinea pigs or mice.

Source and habitat . From acute appendicitis, pulmonary gangrene, abscesses of the urinary tract, and septicaemias in man.

2. Bacteroides serpens (Veillon and Zuber) Hauduroy et al. (Bacillus serpens Veillon and Zuber, Arch. Med. Exp. et Anat. Path., 10, 1898, 870; Bacillus raditformis Rist and Guillemot, Arch. Med. Exp. et Anat. Path., 1904; Hauduroy et al., Dict. d Bact Path., 1937, 74; Zuberella serpens Prévot, Ann. Inst. Past., 60, 1938, 293.) From Latin serpens, crecping. Rods: Thick, with rounded ends, oc-

curring singly, in pairs, or in short chains, Motile. Gram-negative.

Gelatin: Slow liquefaction, with gas. Agar colonies: Punctiform.

Deep agar colonies: Small colonies in 48 hours, ray-like growth later. Gas produced.

Broth: Turbid, then flocculent growth; some gas with foul odor.

Hydrogen sulfide not formed Litmus milk: Acidified and coagulated

in six days, with no digestion. Acid from fructose, galactose, maltose

and lactore. Coagulated egg white and serum not liquefied.

Angembie

Optimum temperature 37°C.

Experimental pathogenicity: Some strains produce abscesses in rabbits, guinea pigs and mice.

Source and habitat: Acute appendicitis, mastoiditis, pulmonary gangrene, bile tract of dog, and sea water.

3. Bacteroides funduliformis (Hallé' Bergey et al. (Bacillus funduliformi Halle, Inaug. Diss., Paris, 1898; Bacillus thetoides Rist, Thèse de Paris, 1898; Bergey et al., Manual, 3rd ed., 1930, 373; Spherophorus funduliformis Prévot, Ann. Inst. Past., 60, 1938, 298.) From Latin funduliformis, sausage-shaped,

Rods: 1.5 to 30 microns long in pus. often spindle-shaped. Extremely pleomorphic in culture media, showing irregplar filamentous and branching forms. Non-motile. Gram-pegative.

Gelatin: Not liquefied.

Deep agar colonies Lenticular, with some gas and foul odor.

Brath: Flocculent growth.

Glucose broth: Rapid growth with gas and foul odor.

Indole not formed; although sometimes found in old cultures. Hydrogen sulfide is formed in small

amounts. Litmus milk: Acid and coagulation by

some strains.

Acid and gas from fructose, glucose and maltose. Some strains ferment maunitol, sucross and lactose

Insombie

Ontimum temperature 37°C.

Experimental pathogenicity Some strains are pathogenic for rabbits and guinea pigs but not for white rats and mice.

Source and habitat: Female genitalia, urinary infections, puerperal infections, acute appendicitis, otitis, pulmonary gingrene, liver abscesses, septicaemins and intestinal true:

1. Bacteroides siecus Eggerthand Gagnon (Eggerthand Gagnon, Jour Bret, 25, 1933, 410, Spherophorus siecus Prévot, Ann Inst Part, 60, 1938, 299) From Latin siecus, dry

Short, thick rods: About 10 meron long. In glucose broth they are cocoud and often grow in short chains. Non-mottle. Gram preative.

Gelatin Not honefied

Blood agar colonies. Elevated, dry, difficult to emulsify, 10 to 15 mm in diameter

Broth: Growth occurs as a powdery sediment with a clear supernatant fluid Indiale not formed

Hydrogen sulfide is formed

Milk Unchanged.

Aitrites not produced from mitrates Acid but no gas from fructuse No acid or gas from glucose, glyceml, mannatol, sorbitol, arabinose, galicin, trebalose, amigidain, cellobose, glycogen, thrun nese, xilose or histose.

Non-pathogenic for white mice and

Anzembie

Distinctive characters Gas is formed in small amounts from poptone red and brom creed purple are decolorized in meat influence broth

Source Two strains isolated from

Habitat: Probably intestinal canal of mammals

5 Bacteroldes coaguians Eggerth and Gagnon. (Eggerth and Gagnon, Jour Bact, 25, 1933, 409; Pasieurella coaguians Prévot, Ann Inst. Past, 60, 1938, 292) From Latin coaguians, execulating.

Rods. 0 5 to 2.0 microns long Bipolar staining. Non-motile. Gram-negative.

Gelatin: Liquefied in S to 12 days.
Blood ager colonies, Soft transception.

05 mm in diameter.

Indole is formed.

Hydrogen sulfide is formed.

Milk Congulated in 8 days without and production. The congulum partly reduced year 2 to 4 weeks

Natrates not produced from nitrates. Non-pathogenic for white mice and rabbits

Annerobie.

Distinctive characters. No acid or gesfrom carbohydrates. A small amount of gas is formed from peptone. Phenol red and brom cresol purple are decolorized in a meat infusion broth.

Source One strain reduced from human ferres.

Habitat Probably intestinal canal of maramais.

6 Bacteroides varius Eggerth and Gagnon (Eggerth and Gagnon, Jour, Bact, 23, 1933, 409, Spheruphorus rorius Privot, Ann Inst Part, 60, 1938, 299.) From Latin rorius, diverse.

Rods 10 to 30 microns long Staining uneven Non motile Gram regulate. Gelatin Not inquefied in 45 days.

Blood agar colonics. Very fint cones, 20 to 30 mm in diameter.

Broth Diffurely clouded Indole is formed

Hydrogen autfide produced.

Milk. Not acadified or engulated. Natrates not produced from nitrates.

And and gra from fructore, galactore, glucose and manners. No acid or gra from seculin, amplicatin, arabinees, cello-hose, destrin, glycerol, glycegon, inulin, lattore, maltore, mannitol, melesitore.

raffinose, rhamnose, salicin, sorbitol, starch, sucrose, trchalose or xylose.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Distinctive characters: Gas is formed from peptone. Brom crosol purple and phenol red are decolorized in a meat infusion broth.

Source: Two strains isolated from human feces.

Habitat: Probably intestinal canal of mammals.

 Bacteroides inaequalis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact, 25, 1933, 407; Spherophorus inaequalis Prévot, Ann. Inst. Past, c0, 1938, 293.) From Latin inaequalis, unequal. Rods. Wide variation in size and form.

Marked pleomorphism on blood agar. Non-motile. Gram-negative.

Gelatin: Not liquefied in 45 days.

Blood agar colonies: Pin-point in size. Broth Diffusely clouded.

Indole is formed.

Hydrogen sulfide is produced.

Milk: Acidified but not coagulated, Nitrites not produced from nitrates.

Acid but no gas from esculin, amyg-dalin, arabinose, fructose, galactose, glucose, lactose, maltose, mannose, raffinose, salicin, sucrose and aylose. No acid or gas from cellobiose, destring glycerol, glycogen, mulin, mannitol, melezitose, rhumnose, sorbitol, starch and trebalose.

Non-pathogenic for white mire and rabbits

Anaerobic.

Distinctive characters: Forms small amount (5 per cent in Smith tube) of gas from peptone water in the complete absence of carbohydrates. None of this gas is absorbed by alkali. Rapidly decolorizes brom cresol purple and phenol red in meat infusion broth; slowly or not at all in peptone water.

Source One strain isolated from human feces

Habitat: Probably intestinal canal of mammals.

8. Bacteroides Insolitus Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 408; Ristella insolida Prévot, Ann. Inst. Past., 60, 1938, 291.) From Latin insolidus, uncompon.

Short thick rods: 1.0 to 2.0 microns long. Often slender, curved, 2.0 to 3.0 microns long. Non-motile. Gram-negative.

Gelatin: Not liquefied in 45 days.

Blood agar colonies: Minute, trans-

Broth: Heavy, diffuse growth.

Indole is formed.

Hydrogen sulfide is formed.

Milk: Acidified and coagulated in 30 to 35 days.

Nitrites not produced from nitrates. Acid but no gas from fructose, galactose, glucose, glycerol, lactose, maltose and mannose. No acid or gas from esculin, amygdalin, arabinose, cellobiose, deatrin,glycogen, inulin, mannitol, meleritose, raffinose, rhamnose, saficin, sorbitol, starch, sucrose, trehalose and xylose.

Non-pathogenic for white mice and

Anaerobic.

Distinctive characters. Brom cresol purple and phenol red are rapidly decolorized in a meat infusion broth. A small amount of gas is formed from peptone.

Source: One strain isolated from human feces

Habitat: Probably intestinal canal of

9 Bacteroides vescus Eggerth and Gagnon (Eggerth and Gagnon, Jour. Bact., 25, 1933, 406; Fusiforms rescus Právot, Ann. Inst. Fast., 60, 1938, 300) From Latin rescus, small or weak.

Slender, pointed rods: 1.0 to 2.0 microns long, sometimes slightly curved

Bipolar staining, Non-motile Gramnogative

Gelatin Liquefied in S to 25 days Blood agar colonies. Very numute and transparent

Broth Diffusely clouded.

Indole not formed.

Hydrogen sulfide not produced

Milk Neither acidified nor congulated Nitrites not produced from nitrates

Peptone No gas.

Acid but no grs from cellotiose (in 30 days), devtrin, glurose, maltose, mannose and rhatmasse. No acid or gas from esculin, amyglahn, arabinose, galactose, mannitol, meleritose, raflinose, saltent, sorbitol, starch, sucrose, trehalose, vylose, glycerol, glycogen, mulin, lactose or fruetose.

Non-pathogenic for white mice and

Anserobie.

Source One strain isolated from human feces.

Habitat Probably intestinal cand of mammals.

10 Bacteroldes exiguus Eggerth and Gugnon (Figgerth and Gugnon, Jour Bret. 25, 1923, 197, Restella exigua Prévot, Ann Inst. Past., 69, 1938, 292.) From Latin exiguus, small and narrow

Very small slender rods 0.5 to 1.0 nucron long, occurring singly and in pairs. Non-motile. Gram negative. Gelstin Launefied in 16 to 20 days

Blood agar colonies. These are of two types. One is pur-point in size, the other is tirge, gray, moist, 10 to 15 mm in dameter.

Broth Diffusely clouded Indole not formed

Hydrogen sulfide not formed

Milk Acidified and may or may not be congulated in 35 to 40 days

Nitrites not produced from nitrates Peptone No gas.

ted but no gas from fructose, gatetose, glucose, hetner, maltose, mannese, sucross and trelafore. One strain fer ments raffinose. No acid or gas from esculin, amygdalin, arabinose, cellobroc, devtrin, glyceml, glycegen, indin, mannitol, meleritose, rhamnose, sahem, sorbitol, starch or vylose.

Non-pathogenic for white mire and

Anaembie

Source: Two strains isolated from

Halutat: Probably intestinal canal of mammals.

11. Bacteroides uncatus Eggerth and Gagnon (Figgerth and Gagnon, Jour. Bact., 25, 1933, 401; Restella uncota Prévot, Ann Inst. Past., 60, 1938, 291) From Latin uncotus, hooked at the tip.
Hods Extreme variations in sice and

form The ordinary length is 50 to 80 microns Curved and hooked forms common Non-motile Gram-negative.

Gelatin: Liquefied in 16 days. Blood agar colonies Very minute and

transparent
Broth Turbid, growth is slow and

light Indole not formed

Hydrogen sulfide not formed.

Milk Not need fied or congulated. Natrates not produced from nitrates.

Peptone Nogas

veid but no gua fiter 8 to 30 days of inculation from dectrin, fructoe, galactoe, plurose, lateroe, mattice, raffinore, riammore, raliem, earch and sucrose. No acid from cevium, ampgialin, arabinose, cellahose, glycerol, glycerol, unulan reannual, manness, meleritoer, certatol, treliniose or aylore.

Non pathogenic for white mice and talibits

imembre

Source One strain redated from human force

Habitat Probably intestinal canal of manufals

12 Bacteroides sulgatus Eggerth and Gegnon (Eggerth and Gegnon, Jour.

Bact., 25, 1933, 401; Pasteurella vulgata Prévot, Ann. Inst. Past., 60, 1938, 292) From Latin vulgatus, common,

Oval rods: 0.7 to 2.5 microns long, usually occurring singly, sometimes in pairs. One strain formed filaments 10 microns long. Stain solidly, some strains show bipolar staining. Morphology very variable in glucose broth. Non-motife. Gram-negative.

Gelatin: Liquefied in 4 to 20 days by all but one strain.

Blood agar colonies: Soft, translucent, grayish, clevated, 1.5 to 2.0 mm in diameter. Half of the strains are hemolytic. Broth: Heavy and diffuse growth.

Indole not formed.

Hydrogen sulfide is formed.

Milk: Acidified. Congulated by some strains in 5 to 25 days.

Nitrites not produced from nitrates. Acid and a small amount of gas from arabinose, devirin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, raffinose, riammose, starch, sucrose and xylese. Seven strains fermented esculin. No acid or gas from amygdalin, cellobiose, glycerol, mannitol, melezitose, salicin, sorbiol, trehalose, duleitol, erythritol or nositol.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Distinctive characters. Does not form indole; does not produce gas from pertone. This is the commonest species found in the feces of adults. Differs from Bacteroides incommunis in that it does not ferment sunyedalm and cellobiose, but does ferment glycogen and starch. Liquefics gehtin.

Source · Thirty-eight strains isolated from human feces

Habitat: Probably intestinal canal of mammals.

13. Bacteroides incommunis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 402; Ristella incommunis Prévot, Ann. Inst Past., 60, 1938, 291.) From Latin incommunis, not common.

Rods: 0.5 to 1.5 by 1.0 to 3 0 microns, occurring singly. Stain solidly. Non-motale, Gram-negative.

Gelatin: Not liquefied.

Blood agar colonies: Elevated, slightly yellowish, 1 mm in diameter. One strain formed soft colonies; the other was stringy when emulsified.

Broth: Growth is deffuse

Indole not formed

Hydrogen sulfide is formed.

Milk: Acidified but not coagulated; coagulates promptly on boiling.

Nitrites not produced from nitrates.

Peptone: No gas.

Acid and a small amount of gas from amygdalin, arabinose, cellobiose, dextrin, fructose, galactore, glucose, inulin, lactose, maltose, mannose, raffinose, rhamnose, sucrose and xylose. One strain fermented glycogen and starch. No action on esculin, glycerol, mannitol,

melezitose, salicin, sorbitol or trehalose.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Source: Two strains isolated from hu-

Habitat: Probably intestinal canal of mammals.

 Bacteroides distasonis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 403; Rietella dietasonis Prévot, Ann. Inst. Past., 60, 1938, 291.)
 Named for Distaso, Roumanian bacteriologist.

Rods: 0 5 to 0.8 by 1.5 to 25 microns, occurring singly. Staining solidly and having rounded ends Some strains show a few bacilli 5 0 to 8 0 microns long. Non-motile. Gram-negative.

Gelatin: Not liquefied by 16 strains. The remaining 4 liquefied gelatin in 35 to 50 days.

Blood agar colonies: Soft, grayish, elevated colonies, 1.0 to 1.5 mm in diameter. Two strains markedly hemolytic.

Broth: Growth is diffuse

Indole not formed

Hydrogen sulfide is produced Milk; Acidified. All but 4 strains congulate milk.

Nitrites not produced from nitrates

Acid but no gas from amygdalın, cellobiose, dextrin, fructose, galactose, giucose, inulin, kectose, matrose, maarnose, melezitose, taffinose, chammose, esilicin, sucrose, trichalose and x slose little en strains forment esculia Fifteen strains forment esculia Fifteen strains forment esculia Fifteen or grs from arabidose, glycogen, glycerol, mannited or grs from the control of th

Non-pathogenic for white mice and rab-

#### Anaerobic.

Distinctive characters: Usually fails to liquely gelatin. Fails to ferment ambinose.

Source Twenty strains isolated from human feces.

Habitat Probably intestinal canal of

15 Bacteroides tumidus Eggerth and Gegnon (Eggerth and Gegnon, Jour. Bact., 25, 1933, 405, Ristella immida Prévot, Ann. Inst. Past , 60, 1938, 292 ) From Latin tumidus, swollen

Small, thick oral reds: 10 to 15 microns long and occurring singly. The staining is solid. On glucore broth many swollen forms with irregular staining from 1.0 to 40 by 1.5 to 10 microns. The bodies of these swallen forms are assually very pele, with only the ends staining. Mon-motille. Gram negative

Gelatin: Liquefied in 12 to 20 days Blood agar colonies: Soft, grayth,

elevated colonies, I mm in diameter Breth Heavy, diffuse growth

Indole not formed.

Hydregen sulfide is produced Milk: Acidified but not congulated Nitrates not produced from naterics

Pentone: No gas Acid but to gas from deatrin, frur tose, galactose, glucose, glyergen, inulin, lactose, malfose, mannose, mafinose, sociados, bird, starch and sucrose. No acid or gas from esculin, amygdalın, arabinose, reliobose, glyerof, mannitol, melevitose, rhamnose, safichi. trehalose or x lesso transcenting and safichi.

Non-pathogenic for white mide and

A naembie

Source: Four strains isolated from human feces.

Haintat Probably intestinal canal of marnmals.

16 Batteroldes convexus Eggerth and Gagnon (Eggerth and Gagnon, Jour. Bact., 25, 1933, 409, Pasteurella convexa Prévot, Ann. Inst. Past., 60, 1938, 292.) From Latin concexus, convex.

Thick, oval rods: 0 8 to 1 5 microns long, occurring singly or in pairs. In glucose broth, the rods are usually 20 to 3 0 microns long. Non-motile, Gramnegative

Gelatin Liquefied in 20 to 30 days

somewhat opaque colonies, 10 to 15 nm is drimeter.

Broth Heavy diffuse growth Indole not formed.

Hydragen suifide is produced.

Milk Acidified and congulated in 4 days.

day s.

Natrates not produced from natrates

Peptone No gas

Acid and a small amount of gas from

esculin, amygdalin, rellohose, dextrin, fractose, galactose, glucose, glycogen, musin, lactose, maltose, mannose, rafic, mose, starch, sucrose and xylore. No aced or gas from arabinose, glycerol, mannote, melezitose, rhamtose, galicin, sorbatol or trebalose

Non-pathogeme for white mice and milduts

Anserobie

Source Five strains isolated from

Habitat Probably intestinal canal of maminals.

17. Bacteroides ovatus Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact., 25, 1933, 405; Pasteurella orata Prévot, Ann. Inst. Past., 60, 1938, 292.) From Latin oratus, egg.-shapped.

Small oval rods: 05 to 1.0 by 1.0 to 2.0 microns, occurring singly. Stains solidly. Non-motile. Gram-negative.

Gelatin: Liquefied in 4 days.

Blood agar colonies: Soft, grayish, elevated colonies, 1.0 to 1.5 mm in diameter.

Broth: Diffuse, heavy growth.

Indole is formed, Hydrogen sulfide is produced.

Milk: Acidified and coagulated in 4 days.

Nitrites not produced from nitrates, Penione: No cas.

Acid and a small amount of gas from esculia, amygdalin, cellobiose, dextrin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, raffinose, rhamnose, starch, sucrose and xylose. No acid or gas from arabmose, glycerol, mannitol, melezitose, salicin, sorbitol or trehalose.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Source. One strain isolated from human feces.

Habitat: Probably intestinal canal of mammals.

18. Bacteroides uniformis Eggerth and Gagnon. (Eggerth and Gagnon, Jour. Bact, 25, 1933, 400; Rustella uniformis Prévot, Ann Inst. Past., 60, 1938, 201) From Latin uniformis, of a single form Small rods; 0.8 to 1.5 microns long.

Small roug: 0.5 to 1.5 inctons one, occurring singly, with rounded ends. Stain heavier at poles and around periphery. Non-motile. Gram-negative Gelatin. Liquefied by two strains in

15 to 40 days. Six strains did not liquefy. Blood agar colonies: Transparent, soft, elevated, 0 5 to 0.75 mm in diameter.

Broth: Diffuse growth.

Indole formed.

Hydrogen sulfide produced slowly or not at all.

Milk: Acidified and coagulated in 8 to 12 days.

Nitrites not produced from nitrates. Peptone: No gas.

Acid but no gas from esculin, amygdalin, arabinose, cellobiose, destrin, fructose, galactose, glucose, glycogen, inulin, lactose, maltose, mannose, melezitose, raffinoso, salicin, starch, sucrose, trehalose and xylose. No acid or gas from glycerol, mannitol, rhamnose, sorbitol, dulcitol, erythiriol or inositol.

Non-pathogenic for white mice and rabbits.

Anaerobic.

Distinctive characters. Forms indole. Resembles Bacteroides vulgatus.

Source: Eight strains isolated from human feces.

Habitat: Probably intestinal canal of mammals.

19. Bacteroides thetalotaomicron (Distaso) Castellani and Chalmers (Bacillus thetaiotaomicron Distaso, Cent. Bakt, I Abt, Orig, 62, 1912, 444; Castellani and Chalmers, Man. Trop Med., 3rd ed., 1919, 960; Spherocilus thetaiotaomicron Prévot, Ann. Inst Past, 69, 1938, 300.) The combination theta, iota and omicron is used because the pleomorphic rods have the shape of these Greek letters

Description taken from Distaso (loc. cit.). More complete description will be found in Eggerth and Gagnon (Jour. Bact., 25, 1933, 399).

Short, plump to oval rods. Stain solidly or only at roles Sometimes with bar causing organism to resemble Greek letter theta. Motile (Distaso). Nonmotile (Eggerth and Gegnon). Gramnegative.

Gelatin. No liquefaction

Glucose agar colonies: Large, transparent, entire Sometimes form gas bubbles

Broth Turbid.

Fre alliumen broth Athuman not attecload

Indate is formed

Hydrogen sulfide produced (Legerth and Gamon)

Litmus milk · Acid. coagulated Curd

shrinks with exaulsion of turbid wher Nitrates not recorded (Distaso) trates not produced from patrates (I'm. corth and Garnon).

Penione No ras (Egreeth and Gagnoni

Arid and gas from esculin, amygdalin, arabinose, fructose, inulin, lactose, cellobiose, dextrin, galactose, glucose, glycogen. maltose, mannose, melezituse, raffinose, rhamnose, sahein, starch, sucrose, trebalose and xylose Four strains fail to produce gas from any sugar No acid or gas from glycerol, mannitol or sorbitol (Egreth and Gagnon)

Anserobia

Distinction characters Resembles Bacieroides variabilis but is not cap sulated, does not liquely gelatin, usually forms gas from sugars, and ferments melezitore and trebalose Differs from Bucterordes uniformis in morphology, forming mis from sugars and in ferment

ing rhamnose (Pererth and Gagnon) Source Isolated frequently from human foces

Haintat - Intestinal canal of manimals (common)

20 Bacteroides variabilis (Distant) Castellani and Chalmers (Recillus carcabiles Distaso, Cent f Bakt, I Abt , Orig , 62, 1912, 411 Castellan and Chalmers, Man Tren Med , 3rd ed , 1919, 960, Capsularis carralalis Prévot, Ann Inst Past . 60, 1938, 293 ) From Latin carrability, variable

Short mile, with rounded ende, occur ring singly Some long flexuous ride Capsulated Non mottle Gram negative

Gelitin No growth on plain gehtin (Distant), honefaction il ggerth and Gagnon, Jour Baet , 25, 1933 400)

Blood agar colonies: Smooth, glistening. elevated and very mucoul, about 1.0 mm in diameter

Broth Diffuse courth

Indole is formed

Hydrogen sulfide is formed.

Litmus milk - Unchanced (Distaso): acidified and some strains congulating in 25 to 35 days (Errerth and Gagnon).

Nitrites not produced from nitrates (Farerth and Gagnon)

Pentane: No gras.

Acud and cas from clucore. Inclose and sucrose (Distaso) Acid and no ras from esculan, amvedalin, arabnose, cello hose, destrin, fructore, galactose. els coren. mulin. lactore. maltose, mannose, raffinose, rhamnose salarin, starch, sucrose and valose No acud or cas from elverrol, mannitol, melezitose, sorbitol or trelialose (Cr. gerth and Gagnon).

Non nathogenic for white mice and ---

Anaemine

Optimum temperature 37°C

Distinctive characters Capsulated. Source Isolated from human feers by Distaso, and by Eggerth and Gignon ( struns)

Habitat Probably intestinal canal of districted.

21 Bacteroides gulosus Liccorth and Gegnon (Eggerth and Gagnon, Jour. Bact , 25, 1933, 398, Spherophorus gulosus Prévot, Ann Inst Past . co. 1938, 298 ) From Latin gulasus, gluttonous

Small oval rods 0.5 to 10 bs 10 to 20 microns, staining deeper around periods. Non motile Gram regative

Geliten Liquefied in 2 to 3 neeks Blood ager colonies, Soft, gm; entire, elevated, 2 mm in diameter

limith Heavy and diffuse growth.

Indole formed Hydrogen sulfide is formed

Milk tends fed and congulated in 1 to 3) days

Vitrites and pastured fanta natrates

al,

٠k٠

Acid and a very small amount of gas from esculin, amygdalin, arabinose, cellobiose, dextrin, fructose, galactose, glycogen, inulin, lactose, glucose, maltose, mannitol, mannose, melezitose, raffinose, rhamnose, salicin, sorbitol, starch, sucrose, trehalose and avlose, Sorbitol and mannitol require 2 to 3 weeks for fermentation. Neither acid nor gas from glycerol, dulcitol, erythritol or inositol.

Pentone: No cas.

Non-pathogenic for white mice and rabbits.

Anserobic.

Source: Seven strains isolated from human feres.

Habitat: Probably intestinal canal of mammals.

22, Bacteroides melaninogenicus (Oliver and Wherry) Roy and Kelly. (Bacterium melaninggenicum Oliver and Wherry, Jour Inf. Dis., 28, 1921, 341; Hemophilus melaninogenicus Bergey et al., Manual, 3rd ed., 1930, 314; Ristella D-treat Ann Inst Past...

producing.

Description taken from Oliver and Wherry (loc. cit.) and Burdon (Jour. Inf. Dis., 42, 1928, 161)

Rods: 08 by 10 to 30 migrons Nonmotile. Gram-negative.

Serum gelatin stab: Dense flocculent growth at 37°C. No liquefaction.

Blood agar slant: Confluent, black, dry layer. The blood is disintegrated in one to two weeks forming melanin.

The medium becomes colorless. Sodium phosphate broth . Turbid.

Litmus milk. Slow acidification but no coagulation.

Blood serum slant: Fairly luxuriant, white, moist layer.

Acid from fructose, glucose, lactose, maltose, sucrose and mannitol. No acid from galactose

Non-pathogenic for rabbits, guinea

pigs and white mice (Burdon). Anaerohic

Optimum temperature 37°C.

Distinctive characters: Growth very poor unless fresh body fluids are added to the medium. Grows more readily in mixed culture. When grown on a medium containing haemoglobin, a black pigment is produced (melanin).

Source: Oral cavity, external cenitalia. infected surgical wound, urine and

feces (Ohver and Wherry).

Habitat: Inhabits healthy mucous membranes of mammals, but may take a part in various pathological processes (Burdon).

23. Bacteroides caviae (Vinzent) Haudurov et al. (Streptobacillus caviae Vinzent, Ann. Inst. Past., 42, 1928, 533; Hauduroy et al., Dict, d. Bact, Path., 1937, 53; Spherophorus caviae Prévot. Ann. Inst. Past., 60, 1938, 299.) From Cavia, a genus of rodents.

Rods: Small, sometimes curved, Usually 0.3 to 0.5 by 1.0 to 1.5 microns. Occurring singly and in chains. Picomorphic in old cultures with long filamentous forms. Non-motile. Gramnegative.

Serum gelatin: No liquefaction.

Serum agar, Surface colonies, small, translucent, slightly raised, adherent to medium in 48 hours. Deep colonies, lenticular, 2 mm in size in 48 hours. Colonies difficult to break up. No gas. Serum broth: Supernatant fluid clear,

with small, stellate colonies, which tend to adhere to nalls of the tube. No gas. Indole not formed in serum peptone

Hydrogen sulfide not formed. Milk. Unchanged.

Congulated egg white and serum not liquefied.

No seid or gas from carbohydrates. Pathogenic for guinea pigs, rabbits and

mice.

Anaerobic.

Optimum temperature 37°C.

Distinctive characters: No growth unless serum is added to the medium. Source: From epidemic benign rervical adentis of gunes pics.

Habitat: Infected guinea pigs so far

as know

Appendix 1: Additional species which may belong here.

Bacteroides laccia (Distaso) Bergey et al (Bacillus lacris Distaso, Cent f Bakt., I Abt., Orig. 62, 1012, 444, Berges et al., Manual, 1st ed., 1923, 257, not Bacillus laccis Frankland and Frank land, Phil. Trans. Roy. Soc London, 178, B. 1857, 278). Prom feces

Bacteroides liquefacters (Distaso: Bergey et al. (Coccobacillus liquefacters) Distaso, Cent. f. Bakt. I Abt., Orig., 59, 1911, 102; Bergey et al., Manual, 1st. ed., 1923, 2021. From feces

Bacteroides rigidus (Distaso) Bergiv et al. (Bacillus rigidus Distaso, Cent f. Bakt., I Abt., Orig., 59, 1911, 301, Bergev et al. Manual. ist ed., 1923, 283)

Appendix II\*: Prévot (Ann Inst Past, 69, 1938, 285 and Man, de Cliss et de Déterm, des Bact, Anaérobies, 1940, 38) has arranged some of the ancreobic, non-spore-forming, Gram-negative, largely parasitie rods in two families. Ristellaccae and Spherophoraccae, as follows

Family Ristellaceae Prévot (Ann. Inst. Past., 60, 1938, 28) Genus I. Ristella Prirot

(Lec. est , 289 )

Straight or slightly bent, non-motile rods. Not capsulated. Gram negative Ansemble,

1. Histella fragilis See Bacteroides fragilis,

jragins,

- 2. Ristella melaninogenica. See Bacterosdes melaninogenicus.
- 3 Ristella haloseptica (Wyss) Prévot. (Bacterium halosepticum Wyss, Mitt. Grenz Med. u. Chir., 15, 1964, 192; Prevot, loc est, 201) From a fatal case of esteempelistis in man For a description of this species, see Manual, 5th ed., 1930, 570.
- 4 Bistella putredinis (Weinberg et al.) Prévot (Barillas A, Heyde, Bestr. 2, klas Chirurg, 76, 1911, 1; Borillas putredinis Weinberg et al., Les Microber Anaferbure, 1937, 755, Prévot, loc. cit., 291) Fifteen strains isolated from arute appendiettis For a description of this species, see Manual, 5th ed., 1939, 671.
- 5 Retella terdinans (Brocard and Pham) Prévot. (Bacellus terdinan Brocard and Pham, Compt rend Soc. Biol., Paris, 117, 1931, 997; Prévot, loc. cit., 231) Two strains isolated from cases of grageroous ery spelas, associated with a streptococcus. For a description of this species, see Manual, 6th ed., 1939, 671.
- 6 Ristella fureasa (Veillon and Zuber) Prévot (Bacellus Jureasus Veillon and Zuber, Arch Méd Evp et Anat, Path., 10, 1878, Fusiforms fureasus Topley and Wilson, Princip Bact, and Immun., 1st ed., 1, 1931, 372, Bacteroides fureasus Hauduny et al., Dict. d. Bact. Path., 1937, 63, Prévot, loc ett., 221) Fram execs of appendicitis and from lung abscesses. For a description of this species, see Manual, 5th ed., 1939, 672.
- 7 Rustila putida (Weinlerg et sl.) Pekvot (Decilius gracius putidus Russius anni Martelly, Ann Inst., Past., 16, 1902, 855, Bacillus putidus Weinlerg et al., Les Viccolers Anafroblies, 1937, 700, rot Bacillus putidus Kern, Arb. laks Inst Karlvrube, I. Heft 4, 1856,

\* Rearranged by Mrs. Eleanore Herst Chee, New York State Experiment Station, Geneva, New York, December, 1915

- 400; Prévot, loc. cit., 291.) From putrefying meat. For a description of this species, see Manual, 5th ed., 1939, 573.
- 8. Ristella clostridiiforms (Ankersmit) Prévot. (Bacterium clostridiiformis Ankersmit, Cent. f. Bakt., I Abt., Orig., 40, 1906, 115; Prévot, Icc. cit., 291.) From the normal intestines of cattle. For a description of this species, see Manual, 5th ed., 1939, 574.
- 9. Ristella perfoctens (Weinberg et al.)
  Prévot. (Coccobacillus anaerobius perfoctens Tissier, Thèse Méd., Paris, 1997, 799;
  Bacterium perfoctens Weinberg et al.,
  Les Microbes Anaérobies, 1937, 799;
  Bacteroides perfoctens Hauduroy et al.,
  Dict. d. Bact. Path., 1937, 67; Prévot,
  loc. cit, 291.) From the intestines of
  infants with diarrhoea. For a description of this species, see Manual, 5th ed.,
  1939, 575.
- Ristella thermophila β (Weinberg et al.) Prévot. (Thermo β, Veillon, Ann. Inst. Past., 36, 1922, 430; Bacillus thermophilus β Weinberg et al., Les Microbes Anaérobies, 1937, 800; Prévot, loc. ctl., 291.) From manure. Nonpathogenic.
- II. Ristella thermophila \( \) (Weinberg et al) Prévot. (Thermo \( \) Veillon, Ann Inst. Past., \( \) 59, 1922, 432, \( Bacillus thermophilus \( \) Weinberg et al, \( \) Les Microbes Anaérobies, 1937, 800; Prévot, \( \) loc \( cit., \) 291) From manure. For a description of this species, see Manual, \( 5th \) ed \( , 1939, 575 \)
- Ristella incommunis See Bacteroides incommunis.
- Ristella insolita. See Bacteroides insolitus.
- 14. Ristella halosmophila (Baumgartner) Prévot. (Bacteroides halosmophilus Baumgartner Food Research, 2, 1937, 321; Prévot, Man. de Class. et de Déterm.

- des Bact. Anaérobies, 1940, 47.) From salted Mediterrancan anchovies. Frequently found in the fish muscle and in the solar salt (the probable infecting agent) in which the fish is packed. For a description of this species, see Manual, 5th ed., 1939, 534.
- 15. Ristella naviformis (Jungano) Prévot. (Bacillus naviformis Jungano, Compt. rend. Soc. Biol., Paris, 68, 1909, 122; Prévot, Ann. Inst. Past., 69, 1938, 201.) From the large intestine of the rat. For a description of this species, see Manual, 5th ed., 1939, 573.
- 16. Ristella Inchenis-plani Prévot. (Bacillus of liehen planus, Jacob and Helmbold, Arch. Derm Syph., 3, 1933, 28; Prévot, loc. cit., 291.) From the lesions of an inflammatory skin disease, lichen planus.
- 17. Ristella destillationis (Weinberg et al.) Prévot. (Bacterium, Tunniclif, Jour. inf. Dis., 13, 1913, 283; Bacterium destillationis Weinberg et al., Les Microbes Anaérobies, 1937, 762; Prévot, toc ctt., 291.) From a case of chronic bronchitis.
- 18. Ristella uniformis. See Bacle roides uniformis.
- Ristella distasonis. See Bacteroides distasonis.
- Ristella uncata. Sec Bacteroides uncatus.
- 21 Ristella tumida. Sec Bacteroides tumidus.
- 22. Ristella exigua. See Bacteroides exiguus.
- Ristella trichoides (Potez and Compagnon) Prévot. (Bacillus trichoides Potez and Compagnon, Compt. rend. Soc. Biol., Paris, 87, 1922, 339; Bac-

teroides trichoides Hauduroy et al, Diet. d. Baet Path., 1937, 78, Prévot, loc cit, 292.) From a case of cholcocy stitis. For a description of this species, see Manual, 5th ed., 1939, 572

- 24. Ristella glutinosa (Guillemot and Hallé) Prévot. (Bacillus glutinosus Guillemot and Hallé, Arch Méd 1:pe et Anat. Path., 16, 1904, 599, Bacteroides glutinosus Haudurey et al, Diet d Bact. Path., 1937, 61, Prévot, lor cit, 292.) From purulent pleurisies
- Ristella capillosa (Tissier) Prévot (Bacillus capillosus Tissier, Ann Inst Past., 22, 1908, 180; Prévot, loc est, 202.) From the intestines of infants For a description of this species, see Manual, 5th ed. 1939, 573.
- 20. Bittella cylindroides (Rocchi) Prétot. (Bacterium cylindroides Rocchi, Lo stato actuale delle nostre cognizioni su germi anaerobi Gamberine e Parmer ziani, Bologia, 1908; Prévot, loc cri, 272.) From the human intestine For a description of this species, see Manual, 5th ed. 1929, 574.

### Genus II. Pasteurella Trezisan

Tour species See Bacteroides sul gatus, Hacteroides oralis, Bacteroides concezus, and Bacteroides congulans

Genus III Dialister Bergey et al Two species See Dialister

#### Genus IV. Capsularis Prival (Loc. cst., 200)

Characters as for the genus Ristella, but capsulated.

1. Capsularis zoogleiformans (Weinberg et al.) Prévot (Baerilus murosus anaerobius Praumits, Cent f. Bah. I. Abt., Orig., 89, 1922, 125, Bactersum zoogleiformans Weinberg et al., Les

Microbes Ansérobies, 1937, 725; Bacteroides praussnitzii Handuroy et al, Duct d. Bact. Path., 1937, 68; Prévot, loc cit., 293 ) From a purulent empyema in man. For a description of this species, see Manual, 5th ed., 1939, 576.

- 2 Capsularis mucosus (Weinberg et al.) Prévot. (Coccobacterium mucosum amarcobicum Klinger, Cent. f Bakt, ł. Mit., Orig., 62, 1912, 185; Bacterium mucosum Weinberg et al., Les Microbes Anaérobies, 1937, 727, Bacteriuder viscosu Hauduroy et al., Dict. d. Bact Path, 1837, 81; Prévot, Inc. et al., 2023. From a brain abscess following bronchictasis in man. For a description of this species, see Manual, 5th ed., 1939, 575
- 3 Capsularis variabilis See Bacteroides variabilis

#### Genus V Zuberella Prerot.

(Loc. et . 290.)

Characters as for the genus littlella, but mottle with peritrichous flagella.

- 1 Zuberella serpens. See Bacteroides serpens
- 2 Zubreila pracaeuta (Trearr) Prévot (Coccobaeillus pracaeutus Trearr, Ann Inst Part, 22, 1908, 189; Prévot, loc ett. 293) From the intestines of infants. For a description of this species, see Manual, 6th ed., 1979, 577.
- 3 Zuberella clostridicforms mobilis Prévot (Macterium clostridicforms Choukéisté, Am Int. Pat. 15, 1911). 315, Prévot, lee ett. 231 ) From the intestines of a horse. Cloukéisté honeidered his organism the same as Ankeremit a Bacterium clostridicforms, although the former was motile.
- 4 Zuberella aquatilis Privat (Spray and Laux, Amer Water Works Associa-

22, 1930, 235; Prévot, loc. cit., 293) From river water. For a description of this organism, see Manual, 5th ed., 1939, 577.

5 Zuberella variegata (Distaso) Prévot. (Bacillus tariegatus Distaso, Cent. I. Bakt., I. Abt., Orig., 62, 1912, 445; Bacteroides rariegatus Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 960; Prévot, loc. cit., 293.) From the intestines. For a description of this species, see Manual, 6th ed., 1939, 678.

6. Zuberella rhinitis (Tunnicliff) Prevot. (Bacıllus rhinitis Tunnicliff, Jour. Inf. Dis., 16, 1915, 493; Prévot, Ioc. cit., 293.) Thirty-two strains isolated from the nasopharynx in human beings suffering from pharyngitis, tonsilitis, bronchitis and rhinitis, as well as from the nasal mucosa of normal human beings, rabbits, guinea pigs and dogs. For a description of this species, see Manual, 5th ed., 1939, 576.

Family Spherophoraceae Prévot.

(Loc. cit., 289.)

Genus I. Spherophorus Prérot.

(Loc. cit., 297.)

Very pleomorphic rods. Metachromatic granules common in clongated forms. Non-motile. Non-spore-forming. Gram-negative.

1. Spherophorus necrophorus (Flugge) Prévot. (Bacillus der Khlberdiphtherie, Loeffler, Mittell. Khlberdiphtherie, Loeffler, Mittell. Khlberdiphtherie tritulorum Flugge. Die Mikroganismen, 2 Aufl., 1886, 265; Bacillus necrophorus Flugge, ibid, 273, Bacillus necrophorus Flugge, ibid, 273, Bacillus diphtheriae-vitulorum Trevisan, I generi e le specie della Batteriacce, 1889, 13; Bacillus fitiformis Shutz, not Bacillus fitiformis Tils, Ztschr. f. Hyg., 9, 1800, 241; not Bacillus fitiformis Migula, Syst.

d. Bakt., 2, 1900, 587; Nekrosebacillen,

nomyces cuniculi Gasperini, Mittheil. 11 Internat. Med. Congr. Rome, see Cent. f. Bakt., 15, 1894, 684; not Actinomyces cuniculi Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 32; Oospora diphtheriae vitulorum Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2. 1896. 393: Actinomyces necrophorus Lehmann and Neumann, Bakt. Diag., 2 Aufl., 2, 1899, 434; Streptothrix necrophora Kitt, Bakterienkunde, 1899; Corynebacterium necrophorum Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907. 531; Bacillus necroseos Salomonsen, quoted from Lehmann and Neumann, ibid., 532; Cladothrix cuniculi Macé. Traité de Bact., 6th ed., 2, 1913, 753; Bacterium necrophorum Lehmann and Neumann, Bakt. Diag., 7 Aufl , 2, 1927, 504; Fusiformis necrophorus Topley and Wilson, Princip, Bact, and Immun, 1st ed., 1, 1931, 299; Prévot, Ann. Inst. Past., 60, 1938, 298.) Because of the importance of this organism, a description is included here:

Rods: 0.5 to 1.5 microns wide, forming long filaments, up to 80 to 100 microas long. Some authors report branching, others deny this. Short forms are reported by Schmorl to be motile. Gramnegative.

Gelatin stab: No liquefaction.

Agar colonies: Small, dirty-white, circular, opaque, with yellowish center under low power lens. Margin floccose.

under low power lens. Margin floccose.

Agar stab: Yellowish colonies along
needle track. Gas bubbles produced.

Coagulated blood scrum: Small, whitish colonics, becoming opaque, fimbriste. Broth Turbid, with gas. Cheese-like

Indole is formed.

Litmus milk: Cheese-like odor. Acidified and generally coagulated.

Nitrites not produced from nitrates.

Anaerobic.

Optimum temperature 37°C.

Produces a soluble exetoria

Source and habitat: Causes diphtheria in cattle with multiple sclerotic abscesses; gangronus dermatitis in horses and mules; multiple necrotic for in heer of cattle and hogs. One case of human infection reported. Transmissible to mice and rabbits.

- 2. Spherophorus funduliformss See Bacteroides funduliformss
- 3. Spherophorus necrogenes (Weinberg et al.) Prévot. (Bacillus, Kawamura, Jour. Jap. Soc. Vet. Sci. 5, 1926, 22; Bacillus necrogenes Weinberg et al. Les Microbes Annérobies, 1937, 381, Prévot. loc. cit., 298.) From epidemic abscesses in hens.
- Spherophorus necroicus (Nativelle) Prévot (Bacillus necroicus Nativelle, 1936, see Weinberg et al. Les Microbes Anaérobies, 1937, 693, Prévot, loc. cit., 293.) From a case of gruperous appendicitis. For a description of this species, see Manual, 5th ed. 1939, 593
- 5. Spherophorus peritonitis Prévot. (Bacillus, Ghon and Sachs, Cent f Blakt., I Abt., Orig., 53, 1995, 1 and 131, Prévot, loc. cit, 298) From peritonesi exudate.
- 6 Spherophorus gulosus See Bacteroides gulosus,
- 7 Spheraphorus inaequalis See Bac teroides snaequalis.
- 8. Spherophorus rarrus See Bac

terordes rarius.

- 9. Spherophorus siecus See Bacteroides siecus,
- 10. Spherophorus mortiferus (Harris) Prévot. (Bacillus mortiferus Harris, Jour Exp Med., 6, 1901, 519; Prévot.

loc. cit, 299.) I'mm a liver abscess in man. For a description of this species, see Manual, 5th ed., 1939, 551.

- 11. Sphrophorus freundi (Hauduroy et al.) Pr\(\text{tot}\). (Freund, Cent. f Bakt., I Abt., Org., 88, 1922. 6] Betternum of Freund, Weinberg et al., I es Microbes Anaécohes, 1937. 706; Bacteroutes freundas Hauduroy et al., Diet. d Bact. Path., 1937, 57, Pr\(\text{evo}\). (be cet., 299.) From a purulent menngius follouing ofitis in man For a description of this species, see Manual, 8th ed., 1939, \$51.
- 12 Spherophorus pyogenes (Hauduroy et al.) Prévot (Budvy, Cent. f. Bakt, I Aht, Org., 77, 1916, 453, Bacillus pyogenes anacrobius Beh-Johan, Cent I Bakt, I Aht., Org., 87, 1922, 290; Bacteroides pyogenes Hauduroy et al., Dect d Bact Path, 1937, 69, Prévot, loc. ett., 299. I From abaceses of the liver and lungs following septic war wounds. Also from the blood stream following tonsilicetomics: For a description of this species, see Manual, 5th ed., 1939, 582.
- 13 Spherophorus gonidiaformans (Tunniciff and Jackson) Prévot. (Bacillus gonulatormans Tunniciff and Juckson, Jour Inf Dis , 25, 1225, 423, Actinumyces gonulatorms (auc) Bergey et al., Manusl, 3rd ed., 1200, 407, Blacteroides gonulatoformans Haudamy et al., Dict d Bact Path, 1237, 62, Prévot, lor et., 229.) From a tonsil For a description of this species, see Manual, 5th ed., 1327, 522
- 13 Spherophorus faccosus (Weinberg et al.) Prévut (Streptokacillus prograes faccosus Commort and Cycle, Arch. Med Exp. 12, 1700, 233, Bacillus faccosus Weinberg et al., Les Microles Anafondors, 1937, 605, not Becillus faccosus kern, Arb Inkt. Inst. Keitsrute, I, Heft 4, 1875, 421, Bectevillus faccosus Handunger et al. Det d'Inct.

Path., 1937, 55; Prévot, loc. cit., 299.) From blood in pyemia of man. For a description of this species, see Manual, 5th ed., 1939, 590.

15. Spherophorus influenzaeformis (Russ) Prévot. (Bacillus influenzaeformis Russ, Cent. f. Fakt., I Abt., Orig., S9, 1995, 357; Bacteroides russii Hauduroy et al., Diet. d. Ract. Path., 1937, 73; Prévot, loc. cit., 299.) One strain isolated from a perianal abscess and two strains from purulent meningitis in man. For a description of this species, see Manual, 5th ed., 1939, 553.

16. Spherophorus cariae, See Bacteroides cariae

Genus II. Spherocillus Prérot.

(Loc. cit., 297.)

Characters as for the genus Spherophorus, but motile with peritrichous flagella.

- Spherocillus bullosus (Distaso) Prévot. (Bacillus bullosus Distaso, Cent. I. Bakt, J. Abt., Org., 63, 1912, 443;
   Bacteroides bullosus Castellani and Chalmers, Man Trop. Med., 3rd ed., 1919, 960;
   Prévot, loc cit, 300) From the untestunal canal For a description of this species, see Manual, 5th ed., 1939.
- 2. Spherocellus thetasotaomicron See Bacteroides thetasotaomicron
- Spherocillus wirth: Prévot. (Bacillus, Wirth, Cent f. Bakt, I Abt., Orig, 105, 1928, 201, Prévot, loc cit., 300.)
   From a case of acute otitis.

Appendix III: The following additional species have been found in the literature.

Actinomyces pseudonecrophorus Harris and Biown (Bull Johns Hopkins Hosp., 40, 1927, 203.) From the uterus in cases of puerperal infection. Probably should be classified near Spheropherus. For a description of this species, see Manual, 5th ed., 1939, 579.

Bacillus anaerobius gracilis Lewkowicz. (Arch. Med. Exp., 15, 1901, 633.)

From the mouths of infants.

Bacillus angulosus Garnier and Simon (Presse Méd., 1909, 473.) From the blood of an infant with typhoid fever.

Bacillus annuliformans Massini. (Ztschr. f. gesam. Exp. Med., 1913, 81.) From a tuberculous cavity of man. Pathogenic.

Bacillus circularis major Heurlin. (Bakt. Unters. d. Keimgehaltes im Genitalkanale d. fiebernden Wechnetinnen. Helsingfors, 1910, 168.) From the genital canal. Anserobic. Gram-negative.

Bacillus limitans Heurlin. (Ibid, 165.) From the genital canal. Anaerobic. Gram-negative.

Bacillus nebulosus Hallé. (Hallé, Thèse de Paris, 1898; not Bacillus nebulosus Vincent, Ann. Inst. Past., 21, 1907, 69.) From the human yagina.

Bacillus stellatus Vincent, Ann. Inst. Past., 21, 1907, 62; not Bacillus stellatus Chester, Man. Determ. Bact. 1901, 274.) From water.

Bacillus symbiophiles Shottmuller. (Leitfaden f. d. klin. bakt. Kultur., Berlin, 1923.) From the blood in a case of puerperal fever.

Bacterium albarrani Jungano. (Compt. rend Soc. Biol., Paris, 63, 1907, 302.)

From a case of cystitis.

Bacterium minutissimum Le Blaye and Guggenheim. (Cocco-bacillus minutissimum gazogenes Jacobson, Ann. Inst. Past., 22, 1908, 300; Le Blaye and Guggenheim, Manuel Pratique de Diagnostue Bact, Viget Frères, 1914.) From intestines of infants.

Bacteroides splenomegaliae (Pinoy) Hauduroy et al. (Synbacterium splenomegaliae Pinoy, Compt. rend. Acad. Sci., Paris, 182, 1926, 1429; Hauduroy et al.,

Dict. d. Bact, Path., 1937, 75.3 From cases of splenomeraly in Algeria Pathoronie

Pasteurella anaerobiontica Levinthal (Cent. f. Bakt., I Abt . Ong , 106, 1928. 195.) From the man-pharups of man

Strentabacillus oracilis Guillemot and Hallé. (Guillemot and Hallé, Arch Med Exp et Anat Path 16 1901 500 Bacteroides streptobacilliformes Handu. rov et al . Diet d Buet Path . 1937 76 ) From noted oleurisies.

### Conus II Fuscharte tium Kuntr.

(Knorr, Cent. f. Bakt., I Abt , Orig , 87, 1922, 536. Fuerformis Provot and Fuegaellus Prévot. Ann. Inst. Past . 60, 1938, 300.)

Gram-negative, anaerobic rods, usually with tapering ends. Usually non-motile Stain with more or less distinct granules Key to the species of genus Fusabacterium.

The type species is Pusabacterium plant, tenerals Knore

- I Acid from maltose
  - A No ras produced
  - B. Gas produced
    - 2 Fusubacterium biacutum
- H. No seed from maltase
  - A. Disagrecable odor produced on cultivation
  - B No odor produced

- 3. Fusobacterrum nucleatum 4 Fusebacterium polymerphum

1 I usobacterium planti eineente

I. Fusobacterium nlauti-vincenti Knorr, (Knorr, Cent f. Bakt, I Abt. Orig., 89, 1923, 16; Fusiformes plaute eineenti and Fusiformis eineenti Haudu roy et al . Diet d. Bact Path , 1937, 210 Named for H C Plant and for H Vincent who studied diseases of the respirators tract

The relationships between this organ ism and the following have not been clearly established Fusiforms denisum Hoelling, Arch. f Protistenkund: 19, 1910, 240, Hacillus fusiformis Veillon and Zuber, Arch de med exper 10 1898, 517 (Corynehaeterium funforme Lehmann and Neumann, Bakt Dag. 4 1uft , 2, 1907, 5291, not Barillus furs forms Gottheil, Cent f Bikt , H tht , 7, 1961, 721; Fuerformis funformis Topley and Wilson, Princip of Bact and Immun , 1st ed . 1, 1931, 30)

Weinberg, Nativelle and Privot Les Microbes Analyobies, 1937, 401) and

Prévot (Ann Inst Past , co, 1918, 285) make a distinction between Plant's incillus (Fusocillus plaute) and Vincent's bacillus (Fusiformes fusiformes). the former being actively motile and conput hopenic and the litter non metale and ant hoveme

Rode 05 to 10 by h to 16 r irrors. occurring in pure with blunt code together and outer ends reunted, son etimes in short, curved chains or long spiritum like threads Granules present Nonnotile Gran negrtise

Seron rair elake culture. Mier 36 hours, edonies spherical, up to 0.5 min in diameter thin, sellered boonn

Serum agur plate. Matted growth Michiga scound colonies becomes turbed fort the precipitation of protein No. surface grouth

rerum broth Milks turbulaty

Laver broth No turbobty Gravelewhite, fishs precuntate

\* Arranged by Prof. Robert S. Breed, New York State I aprilliant Station, George. New York, December, 1938, rearranged, December, 1915

#### TRIBE IV. HEMOPHILEAE WINSLOW ET AL.

(Jour. Bact., 5, 1920, 212.)

Minute parasitic forms growing on first isolation only in the presence of hemoglobia ascitic fluid or other body fluids, or in the presence of certain growth accessory substances found in sterile, unheated plant tissue (potato). Motile or non-motile. Commonly found in the mucosa of respiratory tract or conjunctiva.

#### Key to the genera of tribe Hemonhilene.

- I. Aerobes to facultative anacrobes.
  - A. Non-motile
    - 1. Predominantly occurring singly.
    - Genus I. Hemophilus, p. 584. Predominantly occurring as diplobacilli.
  - Genus II. Morazella, n. 500.
  - B. Motile, encapsulated.

Genus III. Noguchia, p. 592. II. Annerobes.

A. Non-motile.

Genus IV. Dialister, p. 594.

#### Genus I. Hemophilus Winslow et al.\*

(Jour Bact . 2, 1917, 561.) From Greek, loving blood.

Minute rod-shaped cells, sometimes thread-forming and pleomorphic. Non-motile. Strict parasites growing best (or only) in the presence of hemoglobin and in general requiring blood serum, ascitic fluid, or certain growth accessory substances

The type species is Hemophilus influenzae (Lehmann and Neumann) Winslow et al.

## Key to the species of genus Hemophilus.

- I. Affecting the respiratory tract
  - 1 Require both V and X growth factors for growth.
    - 1. Hemophilus influenzae.
    - 2. Hemophilus suis.
    - 3. Hemophilus hemoluticus
    - 2 V growth factor sufficient for growth.
      - 4 Hemophilus parainfluenzae.
      - 5. Hemophilus pertussis.
- II. Affecting the genital region.
- 3 X growth factor sufficient for growth.
  - 6. Hemophilus ducreyi
  - 7. Hemophilus haemoglobinophilus.

<sup>\*</sup> Revised by Dr. Margaret Pittman, National Institute of Health, Bethesda, Maryland, October, 1945

Where the relationship to growth accessory factors as known, the following table

-						
	Growth in peptone water containing					
Species	Growth factor	Phospho paridine nu cleatele (1)	Growth factors			
Hemophilus influenzae	-	-	, +			
Hemophilus suis	-	! -	} +			
Hemophilus hemolyticus	-	±	+			
Hemophilus parainfluenzae	-	+	+			
Hemophilus haemoglobinophilus	+		+			

1 Hemonhilus toffuenzae (Lehmann and Neumann) Winslow et al (Koch. Wiener med. Wchnschr , 35, 1883, 1550, Weeks, New York Med Record, \$1. 1887, 571; Influenzahacillus, Pfeiffer, Doutsche med. Wehnsche, 1892, 28, Zischr f Hvg . 15, 1893, 357 . Bactersum influenzae Lehmann and Neumann, Bakt Darg., 1 Aufl . 2, 1896, 187, Barellus enfluenzae Kruse, in Flüere, Die Mikro organismen. 3 Auft 9 1896, 431. Bac tercum acquptiacum Lehmann and Neumann, Bakt Diag , 2 Aufl , 2, 1899, 191. Hemophilus meningitidis cerebro soundles septicemiae Cohen. Ann. Inst. Past 25, 1909, 273, Winslow et al . Jour Bact . 2. 1917. 561 . Coccobacullus pfeiffert Neveu-Lemaire, Précis Paratol Hum , 5th ed , 1921, 20, Hemaphilus community studie Bergey et al . Manual, let ed . 1923, 270 ) From influenza, a discase of the respiratory tract

Common name The Koch-Beeks

Very small rods 0.2 to 0.3 by 0.5 to 2.6 merons, occurring eingly and in pairs, occasionally in alort cleans, and at times long thread forms are seen. Frequently show a marked tendency to hypotr staining. Some strains are encapsulated. Non motile. Gram negative.

Requires both the factors A and V for

Gelatin colonies. As growth Gelatin stab. No growth Blood ager colonies Small, circular, transparent, homogeneous, entire Satellitism with Stanhulneousus

Blood ag ar slant . Thun, fileform, transparent growth

Chocolate agus shut Luxurrant

growth
Blood broth Slightly turbed No

hemolysis

Latmus milk, with blood. Some strains

render it very slightly alkaline Steribzed potato slant. No growth

Fresh unheated sterile potato added to broth favors development

Indole is formed by some strups

Nitrites are produced from intrates. Some eternia attack near of the carbohydrates, while other strains attack various carbohydrates, provided a suitable medium is used. Mainutol and lactors never fermented.

Pathegente

tember, faculi state

Optimum temperature 37°C Maximum 43°C Minimum 26° to 27°C Kelled at 57°C for thirty minutes

Source I-stated by Pfeiffer in covered influence. Lound in conjunctive, now pharms, spatian, states, cerebrespical fluid, blood, and puts from pants.

Hibrita Respiratory track A cause of acute respiratory into clear a, of acute computativities, and of purulent recrugions of children rarely of adults. Re-

short chains. Non-motile. Gramnegative.

Requires the X factor for its growth. Blood agar colonies: Small, clear, transparent, entire. Old colonies become opaque.

Blood broth: Turbid.

Blood milk mixture: Doubtful development.

Indole is formed.

Nitrites produced from nitrates.

Acid but no gas from glucose, fructose, galactose, mannitol, sucrose and xylosc. No acid from maltose, lactose dextrin, arabinose or glycerol. (Rivers, loc. cit.)

Optimum temperature 37°C.

Aerobic, facultative.

Habitat: Occurs in large numbers in preputial secretions of dogs.

Appendix I:\* The following species has been placed in the tribe Hemophitze by Yan Rooyen (Jour. Path and Bact., 43, 1936, 469). It has been pointed out by Buchanan (General Systematic Bacteriology, 1925, 490) that the genus name Streptobacillus is invalid.

Streptobacillus moniliformis Levaditi, Nicolau and Poincloux (Compt. rend. Acad. Sci., Paris, 180, 1925, 1188.)

This organism is regarded as identical with Haverhillia multiformis Parker and Hudson (Amer Jour. Path., 2, 1926, 357) by Van Rooyen (loc cit ). Topley and Wilson (Princip. Bact. and Immun., 2nd cd., 1936, 270) regard it as identical with their Actinomyces muris (Streptothrix ratti Schottmuller), the cause of rat-bite fever. Asterococcus muris Heilman, Jour. Inf Dis , 69, 1941, 32. See Actinomyces muris ratti in the Appendix to the genus Streptomyces. Jordan and Burrows (Textb of Bact , 14th ed , 1946, 614) consider all these names synonymous. Dayson and Hobby (Proceedings, Third Internat Congr. for Microbiol., New York, 1940, Section I, 177) suggest that the pleuropneumonia-like cultures isolated from Streptobacillus montiformis really represent variant phases in the growth of this organism,

Description from Levaditi et al. (loc. cit.) and Brown and Nunemaker (Bull. Johns Hopkins Hosp., 70, 1942, 201).

Streptobacilli: 2.0 to 3.0 microns in length, pleomorphie, with branching filaments up to 30 to 40 microns long, fragmented, bacillary and coccobacillary forms. Swollen and club-shaped cells are found. Morphology is best demonstrated by aniline dyes, e.g. Wayson's plague stain. Non-motile. Gram-negative.

Enriched media are required for good growth. Best liquid media are rabbit blood and broth containing serum or ascitic fluid, Dest solid media are glycerol extract of potato-infusion broth-egg yolk medium and nutrient agar containing serum.

Blood agar or ascitic serum agar: Colonies small, clear.

Blood plates: Growth slow. Numerous small whitish colonies appear on the third day.

Veillon's medium: Punctiform colonies, abundant in depth, less growth at surface. No gas.

Broth with ascitic fluid and globular extract: Good growth, forming clots which precipitate and are rather adherent to one another. Growth rapidly reduces the pH of the medium killing the bacteria in cultures 24 hrs. old.

Milk: Slow growth. No congulation Loffler's serum: Poor growth

Virulent for rabbits and mice.

Good growth at 37°C. Facultative anaerobe. Grows better

under anaerobic conditions in the presence of added CO<sub>2</sub>, than in the presence of air.

Source: Isolated from a case of a febrile,

<sup>\*</sup> Appendixes I and II arranged by Prof. E. G. D. Murray, McGill Univ., Montreal, P. Q., Canada, March, 1946.

senticemic disease, accommunied by arthritie arythema and angina

Habitat . The cause of an acute februle disease sometimes called erythems multiforma

Annendly II: The following species may be identical with some of those listed above or related to them

Racillus marianensis Leber and Prowazek. (Berlin, klin, Wochnschr. 1. 1911, 27) Allied to the Koch-Weeks Bacillus Associated with cases of nink 616

Racellus treel to Neven-Lemaire (Précis Parasitol, Hum., 5th ed., 1921. 21 ) Described by Weeks. The cause of trachoma or granular conjunctivities in tropical countries Transmitted by the domestic fly. Probably intended for the Week's bacillus (Weeks, New York Med Record. \$1, 1887, 571)

Bacterium tussis conculsurae Lehmann and Neumann. (Bacterium, Czaplewski and Hensel. Deut med Wochnschr. 23, 1897, 587, Lehmann and Neumann. Bikt Ding , 2 Aufl , 2, 1899, 192; not Bacterium tussis conculsirae Lehmann and Neumann, thid , 7 Aufl , 2, 1927, 317. Bacillus tusus conculsivae Lehmann and Neumann, abid . 4 Aufl . 2. 1907, 269 ) Considered the cause of who one cough by the original resistors

Hemophilus aphrophilus (Jour Path and Buct . 40, 1910, 497.) From blood and from heart sals out a case of endocarditie

Hemophilus cuniculi Hauduros et al (Hemophilus en Gibbons, Jour Inf Dis., 45, 1929, 288, Haudurov et al., Diet. d. Path , 1937, 219 ) From skin Bact abscesses of rabbits

Hemophilus gallinarum Delipline, Er win and Stuart and Hemophilus galli narum Chot and Lenis (Bacillus hemo alohinophilus corpiae gallinarum De Blicck, Tiplach v Diergeneensk, 59. 1931, 310, also see Vet Jour , 89, 1932, 9, Delaplane, Erwin and Stuart, R. I. State Coll. Sta. Bull. 214. May. 1931. Fliot and Lewis Jour Amer Vet Med Assoc 81 1931 878 ) From edematous fluid from the head of a chicken cause of an infectious rhuntis in chickons

Hemonbilus influen-ae \*\*\*\*\*\*\*\*\*\* (Kairies and Schwartzer) Land (Bacterrum enfluenzae murium Karries and Schwartzer, Cent. f. Bakt., I Abt . Oric . 157, 1936, 351: Lwoff, App. Inst. Past. 62, 1939, 168.) From the lung of a mouse.

Hemophilus meningitidis (Martina) Haudurov et al. (Coccobacillus meningitidia Martins, Compt. rend. Soc. Biol . Paris, 99, 1928, 955; Haudurov et al., Dict. d Bact Path , 1937, 251.) Resembles Hemophilus influencae except that it shows slurgish motility cerebro-spinal fluid.

Hemophilus muris Hauduroy et al (Bacillus of an epizootic of stock mice. Mackie, Van Roovne and Gilrov, Brit. Jour Exp Path , 14, 1933, 132, Hauduroy et al. Diet d. Bact Path. 1937. 255 ) From heart blood, spleen and other organs of mice dving from an epizootic discaso

Hemophilus ous Mitchell, (Jour. Amer. Vet Assoc, 68, 1925, 8 ) From bronchi of sheep

Hemophilus pertusus Ford (Bacillus pertussis eppendorf Jochtmann and Krause, Ztschr f Hyg., 56, 1901, 193; Ford, Textb of Bact , 1927, 615; not necessarily identical with Bordet and Gengou's organism, Hencephilus perlusas Holland, Jour Bact . 8, 1920, 215 ) From the resourators tract and lungs in per-Incere

Hemophilus putoriorum Haudurov et al (Bacterium influences putariorum multiforme Kairies, Zischr. f. Hyg., 117. 1935, 12, Hauduros et al . Diet. d. Bart Path , 1917, 238 / From the respirators tract of ferrets

Lehmann and Neumann (Bakt Dine . 6 Auft . 2, 1929, ap 1 7 Auft . 2, 1927) lest the following apecies as closely related to this group:

Bacillus catarrhalis Jundell. (Hygieae. 60, No. 6 and 7, p. 667.) From cases of acute bronchitis.

Bacillus trachomatis Lehmann and Neumann. (The Bacillus Muller, Lucrssen, Cent. f. Bakt., I Abt., Orig., \$9. 1905, 682.) From conjunctiva.

Bacterium czaplewskii Chester, (Bacillus bei Keuchhusten, Czaplewski, Cent. f. Bakt., 22, 1837, 611; Bacterium tussis convulsirae Lehmann and Neumann, Bact. Diag., 2 Aufl., 1899, 192; Chester, Man. Determ. Bact., 1901, 153.) From sputum in whooping cough. This is not now regarded as being etiologically associated with whooping cough. Bacterium exiguum Staubli. (Münch.

med. Wrhnschr., No. 45, 1905.) From a case of sentic endocarditis.

Bacterium microbutyricum Hellstein. From butter.

Bacterium minulissimus sputi (Luzzatto) Lehmann and Neumann. (Bacillus minutissimus sputi Luzzatto, Cent. f. Bakt , I Abt., 27, 1900, 816 ) From a case of pertussis.

Bacterium polymorphum convulsivum Melfi. (Cent. f. d. gesamte Hygiene, 7. 1924, 133 )

Bacterium septicaemiae canis Paranhos. (Cent. f. Bakt., I Abt., Orig., 50, 1909. 607.)

Streptobacillus urethrae (Cent. f. Bakt., I Abt., Ref., 36, 1905. 59.) From the normal urethra and from cases of chronic cystitis and urethritis.

#### Genus II. Moraxella Lwoff.\*

(Diplobacillus McNab, Klinische Monatsbl. f. Augenheilk., 42, 1904, 64; not Diplobacillus Weichselbaum, Cent. f. Bakt., g. 1887, 212; Lwoff, Ann. Inst. Past., 62, 1939, 168.) Named for Moray, who first isolated the type species.

Small, short, rod-shaped cells, usually occurring singly or in pairs. Non-motile. Parasitic. Aerobic. Gram-negative.

The type species is Morazella lacunata (Eyre) Lwoff.

Key to the species of genus Moraxella.

No growth in gelatin.

1. Morazella lacunaia.

Gelatin liquefied.

A. Rapid liquefaction. No growth in milk.

2. Morazella liquefaciens. B. Very slow liquefaction. Cells capsulated. Growth in milk.

3. Morazella bovis.

 Moraxella lacunata (Eyre) Lwoff (Diplohacille de la conjunctivite subaigue, Morax, Ann. Inst. Past , 10, 1896. 337; Diplobacillus of chronic conjunctivitis, Axenfeld, Cent. f. Bakt., I Abt., 21, 1897, 1, Bacterium conjunctivitis Chester. Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 85, Bacillus lacunatus Eyre, Jour. Path. and Bact., 6, 1899, 1; not Bacillus

lacunatus Wright, Memoirs Nat. Acad. Sci., 7, 1895, 435; Diplobacillus morarazenfeld McNab, Klinische Monatsbl. f. Augenheilk., 42, 1904, 64; Bacterium duplez Lehmann and Neumann, Bakt. Ding , 2 Aufl., 2, 1899, 193; Hemophilus lacunatus Holland, Jour. Bact., 5, 1920, 223; Bacillus duplex Hewlett, Med. Res. Council Syst. of Bact., 2, 1929, 417;

Arranged by Prof. E. G. D. Murray, McGill University, Montreal, P. Q., Canada, September, 1945.

Lwoff, Ann. Inst. Past., 62, 1939, 173; Hemophilus duplex Murray, in Manual, 5th ed., 1939, 308) Prom Latin, pitted.

Audureau (Ann. Inst., Past., 64, 1940, 128) recognizes an atypical variety of this species. To distinguish between the two varieties, she designates there as Morazella licunda var typica and Morazella licunda var typica and Morazella licunda var et spica and Morazella licunda var et spica.

Short rods: 04 to 05 by 20 microns, occurring singly and in rairs and short chains 12nds rounded or square in the chains. Non-motile Gram-negative

Gelatin colonies: No growth

Gelatin stab No growth.

Blood agar colonies: Small, circular, transparent, entire. Growth on subculture difficult. Certain strains are not surrounded by zones of hemolysis, others are (Oag, Jour. Path. and Bact, 54, 1912, 128).

Serum agar colonies: Delicate, grayish
Löffler's blood serum: Slow but definite
liquefaction (pitting) around the
colonies

Ascitic broth Turbid with slight, grayish sediment.

Blood milk mixture. Doubtful de-

Latmus milk. Unchanged

Potato No growth.

Indole not formed.

Nitrites not produced from nitrates.

Various carbohydrates and mannitol
are standed.

Ontinum temperature 37°C.

Acrobic, facultative.

Source From conjunctive

Habitat The cause of subacute infectious conjunctivitis, or angular conjunctivitis

2 Morarella liquefaciens (McNab) comb nor (Diplotacelle liquefacin, Pettit, Annales d'eculatique, March, 190, 160 and Treus, Paris, 1900, 223, Biploborillus liquefaciens McNab, Klimstels Morathil 4 Augerbeilk 42, 1901, 64, Bacillus dupler liquefaciers Lowdi, Ann-Inst. Part, 22, 1909, 1073, Morathil Inst. Part, 22, 1909, 1073, Morathil duplex liquefaciens Lwoff, ibid., 171; Morazella duplex Lwoff, ibid., 171; Morazella duplex var. liquefaciens Audureau, Ann. Inst. Past., 64, 1910, 139.) From Lstip, houefying.

Diplobacilli: 10 to 1.5 by 20 microns, occurring singly and in pairs, and having rounded ends. Capsules not demonstrated. Non-motile Stain uniformly with basic aniline does. Gram-negative. Gelstin, economics Round. 15 to 20

mm in diameter, yellowish-white. Gelatin stab: Rapid honefaction.

Blood agar Ready growth in primary

Ascitic agar colonies: Grayish, thick, round, viscous

ound, viscous
Peptone agar colonies: Same as above,

but less abundant growth.

Congulated scrum: Liquefaction in 3
to 4 days, eventually complete.

to 4 days, eventually complete.

Plain broth. Poor growth, if any
Slight uniform turbidity.

Ascitic broth. Abundant growth in 24 hours at 35°C. Uniform turbidity. Later sediment and an orrique pellicle.

Milk. No growth. No congulation.

Potato Slight, vellouish-white, vis-

cous growth

Optimum temperature between 20°
and 37°C. Killed at 55°C for 15 minutes.

Aerobie.

Not pathogenic for laboratory animals.

Source: From cases of conjunctivitis
associated with corneal ulceration in

Habitat: Conjunctivitie in man so far

3. Morazella bovis (Huuduro) et al.)
comb nor. (Diplolacillus, Allen, Jour
Amer Vet Med Assa, & 1, 1915, 207;
Diplolacillus, Jores and Little, Jour.
Lay Med., 38, 1923, 130, Henophilus
loris Huuduroy et al., Det d' Riet.
Path., 1977, 247, Morazilla duyler des
Broudes, Level, Arm., Irit Tast. & 6,
1979, 174; Henophilus ruminantius
Reid and Adjectin, Texas Reports on

Biol. and Med., 5, 1945, 187.) From Latin boris, of the ox.

Short, plump rods: 0.5 by 1.5 to 20 microns, usually occurring in pairs and short chains, with rounded ends. Capsulated. Non-motile. Gram-negative.

Gelatin: Slow growth at 22°C. Very

slow liquefaction.

Blood agar colonies: After 21 hours, round, translucent, grayish-white, surrounded by a narrow, clear zone of hemolysis. Deep colonies tiny with a clear hemolytic zone, usually 1.5 mm in diameter. After 48 hours, surface colonies somewhat flattened, 3.5 to 4 mm in diameter; deep colonies ellipsoidal and biconvex with hemolytic area of 2.5 to 3 mm in diameter.

Blood agar slants; After 24 hours at 38°C, heavy, viscid, grayish-white growth.

Coagulated serum liquefied.

Broth: Slow growth. Slight turbidity. Considerable sediment.

Litmus milk. Alkaline. Partial coagulation.

Indole not produced

Potato: No growth.

No acid from glucose or other carbo-

hydrates Not pathogenic for laboratory animals.

Killed at 58° to 59°C in five minutes.

Aerobie. Source From cases of acute ophthalmia (pink eye) of cattle

Habitat: In the exudate from cases of acute ophthalmia of cattle. The probable cause of bovine infectious keratitis (Baldwin, Amer. Jour. Vet. Res., 6. 1945, 180).

Appendix: Other species placed in the genus Morazella are as follows:

Morazella josephi Lwoff. (Bacillus duplex josephi Scarlett, Annales d'Oculistique, 153, 1916, 100 and 485; Lwoff, Ann. Inst. Past , 62, 1939, 171; Morazella duplex josephi Lwoff, ibid., 174: Bacillus josephi Audurcau, Ann. Inst. Past., 64, 1940, 126.) Gram-positive. Pathogenic. From the conjunctive of man.

Morazella lwoffi Audureau. (Ann. Inst. Past., 64, 1940, 150.) Two varieties are recognized; var. bacteroides and var. brevis. From various types of

conjunctivitis in man.

Morazella non liquefaciens Lwoff. (Bacterium duplex-nonliquefaciens Oliver and Wherry, Jour. Inf. Dis. 28, 1921, 342; Bacillus duplex non-liquefaciens Hewlett, Med. Res. Council Syst. of Bact , 2, 1929, 418; Lweff, Ann. Inst. Past., 62, 1939, 171; Morazella duplex non liquefaciens Lwoff, ibid, 174: Bacillus duplex non liquefaciens Audureau, Ann. Inst. Past., 64, 1940, 126; Morazella duplex var. non liquefaciens Audureau, ibid., 144.) From an ulcer of the cornea, and from bronchial sputum in man

Genus III. Noguchla Olitsky, Syverton and Tyler.\*

(Jour. Exp. Med , 60, 1934, 382.) Named for Noguchi, the bacteriologist who isolated the type species.

Small, slender, Gram-negative rods present in the conjunctive of man and animals affected by a follicular type of disease; mucoid type of growth which on first isolation takes place with some difficulty in ordinary media; motile, flagellated, and encapsulated; aerobic and facultative anaerobic; optimum temperature for growth 28° to 80°C.

The type species is Noguchia granulosis (Noguchí) Olitsky, Syverton and Tyler.

Key to the species of genus Noguchia.

I. Acid from carbohydrates.

A. Acid from raffinose, maltose and salicin. Noguchia granulosis.

<sup>\*</sup> Arranged by Prof. C. D. Kelly, McGill University, Montreal, October, 1933.

- B. No acid from raffinose, maltose and salicin.
- II. No acid from carbohydrates.

2. Noquehia simiae.

3. Noouchia euniculi.

 Noguchia granulosis (Noguchi) Olitsky et al. (Bacterium granulosis Noguchi, Jour. Exp. Med , 48, Supp. 2, 1928, 21; Olitsky, Syverton and Tyler, Jour. Exp. Med., 60, 1931, 382.) From

Latin, granular,

Rods: 0 25 to 0 3 by 0 8 to 1.2 microns. motile by means of a single flagellum, usually polar. Pleomorphie, Gram-negative.

No growth on plain agar or broth

Blood agar plate. Minute round colonics, shiny, somewhat raised, almost transparent or slightly grayish in 48 hours Later the colonies merease in size, are grayish opalescent and somewhat sticky. Old colonies have a brownish or yellowish tint.

Semi solid Leptospira medium. Grayish-white, diffuse growth, forming a delicate zone I em deen.

Liquid Leptospira medium. Diffuse. slightly cloudy growth, with sticky grayish sediment at the bottom of the tube in old cultures.

Acid from glucose, fructose, mannose, sucrose, galactose, maltose, salicin, xylose, mannitol, dextrin, arabinose, amygdalin and lactose Small amount of seed from raffinose, inulin, rhamnose and trehalose. No acid from dulcitol. lotizoni fore fotidos

Non-pathogenic for rabbits, guines pigs, rata and mice.

Optimum pH 7.8.

Temperature relations Optimum 15\* to 30°C Grows at 37°C

Acrobe, ficultative anaembe

Distinctive characters. Action on earlobs drates, agglutination reactions, motibty at 15°, none at 37°C

Source Term trackoma of American Indians at Albuquerque, New Mexico Halitat, Regarded by Neguchi and

others as a cause of trackoma in man

Produces a granular conjunctivitis in monkeys and ares 2. Noguchia simiae Olitsky et al

(Bacterium simiae Olitaky, Syverton and Tyler, Jour. Exp. Med., 57, 1933. 875, Olitsky et al , Jour, Exp. Med , 60, 1931, 382.) From Latin simia, ape. Slender rods: 02 to 03 by 0.8 to 12 microns, occurring singly, in pairs, in short chains or rarallel arrangement of two or three, having pointed ends. Capsules are found. Actively motile by means of a single, rarely a double, flagellum, usually polar. Gram-negative

Gelatin plates. Colonies more mucoud and raised than on agar.

Gelatin stab: Arachnoid growth along line of inoculation No liquefaction Ager plates. Small, circular, grayish,

translucent, smooth, convex, slightly raised colonies having a sticky or mucoid consistency. Blood agar plates . More highly translu-

cent and colorless in early growth than on plain agar, becoming gray ish after two or three days. Ame slants Grayish-white to white,

morst, mucoid, raised, glistening growth. Growth is more profuse when blood is added. Leptospira medium: Homogeneous,

dense growth in a 0.5 cm sharply defined layer, with a elight, nebulous, uniform emerty about 1 cm below. In three or four days the loner layer becomes more dense and in time extends to the bottom of the tube

Broth Uniform turbidity, with a slight grasish redin ent and no pellicle.

Litmus rill Urclarged Potato Lag! t tan, spreading, aburdent

grouth Ind ic sat force!

Natures not produced form natrates Acid but to gas from glumer, fructour, mannose, galactose, xylose, arabinose and rhamnose. Small amount of acid from dextrin. Some strains produce a small amount of acid from sucrose, lactose, inulin and mannitol. Raffinose. salicin, dulcitol, amygdalin, maltose, trebalose, sorbitol and inositol chanced.

Serological reactions: Rabbit antiscrum is specific for all strains and no cross agglutination with Noguchia granulosis.

Temperature relations: Optimum 28° to 30°C. Thermal death point 56°C for thirty minutes.

Aerobe, facultative anaerobe.

Distinctive characters: Action on carbohydrates; agglutination reactions.

Source: From inflammatory type (Type II) of spontaneous conjunctival folliculosis in Macacus rhesus monkeys.

Habitat: Causes conjunctival folliculosis in Macacus thesus monkeys.

3. Noguchia cuniculi Olitsky, Syverton and Tyler. (Jour. Exp. Med., 60, 1934, 382 ) From Latin cuntculus, rabbit.

Slender rods. 0 2 to 0.3 by 0.5 to 10 micron with pointed ends. Capsules are formed of much finer texture than those surrounding Noguchia granulosis or Noguchia simiae. Actively motile with peritrichous flagells. Non-acid-Pleomorphic forms sometimes fast. noted. Gram-negative\*

Gelatin agar plates Grayish, mucoid and confluent colonies

Gelatin stab. Tenuous, arborescent, non-spreading growth No liquefaction Agar plates Small, spherical, translu-

cent, slightly grayish, smooth, somewhat convex, moist and mucoid colonies with entire edges

Blood agar plates. More profuse, more grayish and less translucent than on plain

agar.

Agar slants: Slightly grayish, translucent. coalescent. glistening, mucoid. homogeneous and non-spreading growth, The water of syneresis appears uniformly cloudy or milky depending on amount of gmwth.

Leptospira medium: After 24 hours, a faint, nebulous surface growth followed by an incrowing sac-like mass, with its base 5 mm across, lying at the center of the under surface and extending for 5 mm into the medium. The area spreads laterally until at about two or three days there is a uniform, opaque, whitish layer about 1 cm thick which progresses slowly until the bottom of the tube is reached in about seven days.

Broth: Uniform turbidity, without pellicle.

Litmus milk: Unchanged.

Potato: Faint, buff-colored (changing to brown after five days), non-spreading, sparse surface growth.

Indole not produced.

Nitrites not produced from nitrates. No acid or gas from glucose, fructose, mannose, mannitol, sucrose, raffinose, mulin, galactose, maltose, salicin, xylose, dextrin, arabinose, amygdalin, lactose, dulcitol, rhamnose, trehalose, sorbitol or inositol.

Serological relations: Rabbit antiserum is specific for all strains, and no cross agglutination with Noguchia granulosis or Noouchia simiae.

Temperature relations: Optimum 28° to 30°C. Thermal death point 56°C for 15 to 30 minutes.

Aerobe, facultative anaerobe.

Distinctive characters: No action on carbohydrates; peritrichous flagella; agglutination. Source: From spontaneous conjunctival

folliculosis, Type II of rabbits. Habitat: Causes conjunctival follieu-

Genus IV. Dialister Bergey et al.\*

losis in rabbits.

(Manual, 1st ed , 1923, 271.)

Minute rod-shaped cells, occurring singly, in pairs and short chains. Non-motile.

Rearranged by Prof. D. H. Bergey, Philadelphia, Pennsylvania, 1933.

Strict parasites. Growth occurs only under amerobic conditions in media containing fresh, sterile tissue or assitio fluid.

The type species is Dialister pneumosintes (Olytsky and Gates) Berrey et al.

 Dialister pneumosintes (Olitaky and Gates) Bergey et al. (Bacterium pneumosintes Olitaky and Gates, Jour Eyp. Med., 55, 1921, 713; ibid., 55, 1922, 813; Bergey et al., Manual, 1st ed., 1923, 271; Bacillus pneumosintes Ford, Texth. of Bact., 1927, G31.) From Greek pneumon, lung and sintor, murderer or devastator.

Very short rods: 0.15 to 0 3 (in glucose broth 0.5 to 1.0) micron in length, occurring singly and occasionally in pairs, short chains or masses. The ends are rather pointed. Non-motile. Gramnecative.

Blood agar colonies. Small, elear, circular, entire, translucent.

Growth occurs in media containing fresh sterile rabbit kidney and ascitic fluid. Under strict anaerobic conditions good growth on rabbit blood glucose agar plates.

Glucose broth in which Escherichia coli or Bacillus mesentericus (non-spore stage) has grown favors growth

Acid but no gas from glucose Neither acid nor gas from maltose, lactose, sucrose, inclin or mannitol.

Passes Berkefeld V and N filters Optimum pH 7.4 to 7.8. No growth at pH 7.0 or pH 8.0.

Optimum temperature 37°C. Does not survive 56°C for half an hour.

Pathogenic for rabbits and guinea pigs Strict anaembe

Source From filtered nasophary ageal secretions from influenza patients in the early hours of the disease.

Habitat: Nasopharyngeal washings of

 Dialister granuliformans (Pavlovic) Bergey et al. (Bacterium granuliformans Pavlovic, Cent f. Bakt, I. Man-Jorie, 112, 1929, 132; Bergey et al., Manual, 4th ed., 1931, 311.) From Latin, forming granules

Small rods, Non-motile, Gram-nega-

Agar colonies: Very small, transparent. No gas.

Broth: Turbid.

Litmus milk: Unchanged.

Indole not formed,

Acid from glucose, sucrose and mannitol

Passes through Chamberland L<sub>2</sub> filters.

Pathorenic for rabbits.

Ontinum temperature 37°C

Anaerobic to microserobilic.

Source. From respiratory tract in

Habitat: Mucous membrane of respiratory tract.

Appendix, Family Parvobacteriscene: De Bord (Iowa State Coll. Jour. Sci., 16, 1942, 471) describes a new tribe. Mamege, which may belong in this famdy The tribe includes three genera; Mema with the species Mima polymorpha and the variety Mima polymorpha var. oxidans; Herellea with the single species Hereilea rannicola: and Colloides with the single species Colloides anoxydana. The organisms are Gram presture, pleamorphic, motile or non-motile rolls, often showing bijolar staining, and were related from the normal vagina and from cases of vaginitis and conjunctivities Dracon (Jour. Bact , 49, 1945, 511) classifire nineteen cultures in these reners.

<sup>\*</sup> Arranged by Dr. A. Parker Hitchens, University of Pennsylvania, Ph.Jadelphia, Pa., March, 1916

## FAMILY XII. BACTERIACEAE COHN.\*

(Arch. f. path. Anat. u. Physiol., 55, 1872, 237.)

Rod-shaped cells without endospores. Motile or non-motile. Gram-positive and Gram-negative. Metabolism complex, amino acids being utilized, and generally carbohydrates.

This is a heterogeneous collection of species whose relationships to each other and to other groups are not clear.

Only a single genus is recognized at this time.

# Genus I. Bacterium Ehrenberg.

(IV. Evertebrata, Berlin, 1828, 8.)
The original description of this genus follows:

Bacterium, Novum Geaus, Familia Vibrionorum Character Generia: Corpus polygratricum? anenterum? nudum, oblongum, fussforme aut filiforme, rectum, monomorphum (contractione nunquam diatatum), parum Revila (nee aperte undatum), transverso in musika partes sponte dividuum.

This may be translated as follows:

Bacterium, new genus Family of Vibrions Character of the genus: Body with many atomachi? without an untestine? naked, oblong, spindle-shaped or filiform, straight, monomorphic (in contraction never chiated), not very plant (and not definitely wavy), freely separated transversely into many parts

The type species is Bacterium triloculare Ehrenberg.

The original description of this species follows:

B. triloculare nov. spec., distincte triloculare s trarticulatum, subfusiformum, hyalimum.
Animaloulum 1/800 lineae longum, corpore terets. Artuculas espita interna divisionem instantem multipl

los replere hae formae respunt

ideoque ad Polygastrica non misi dubitanter et interiii conocanoma.

This may be translated as follows:

B. triloculare new spec Definitely with three compariments or three jointed, subfoundern, by since.

Animalcules 1/300 of a line in length, with a smooth body. The joints of internal septs are observed to develop preliminary to multiple transverse splitting. A motile but sluggish animalcule. Observed in the

re. These forms refuse to fill their stomachs with lev and only temporarily in the Polygastrica.

The original descriptions are taken from Buchanan, General Systematic Bacteriology, 1925, 213, and the translations are also furnished by him. Buchanan in his book gives an excellent summary of the nomenclatural status of the term Bacterium

ies of non-spore-

ssification is not

forming, rod-shaped bacteria whose position is not definitely established (Breed and Conn, Jour. Bact , 51, 1936, 517).

Completely rearranged by Prof. Robert S. Breed and Mrs. Eleanore Heist Clise.
 New York State Experiment Station, Geneva, New York, May 1946.

Bacterium triloculare Ehrenberg. (Ehrenberg, IV. Evertebrata, Berlin, 1828, 8; Bacillus ehrenbergii Trevisan, I generi e le specie delle Batteriacce, 1899, 18; Bacterium ehrenbergii De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1922; Bacterium lincola Cohn, Beiträge z. Biol. d. Pflanten, I, Hett 2, 1872, 170). Cohn also regards Vtrio lincola Miller, 1785 and Vibrio lincola Gacillus tinoda, Bactrium lincola) of other authors as synonyms of Bacterium triloculare as explained by Buchanan (loc. cit, 213 and 621). From Latin tri, three and loculus, cells or compartments.

Key to the remaining species of genus Bacterium.

## I. Gram-positive.

- A. Non-motile.
  - 1. Nitrites produced from nitrates.
    - 1. Bacterium erythrogenes.
    - 2. Bacterium zubrufum.
    - 3 Bacterium linens.
    - Bacterium mycoides.
    - 5. Bacterium mutabile. 6. Bacterium qualis.
  - 2. Nitrites not produced from nitrates.
    - a. Grow on ordinary media
      - 7 Bacterium racemosum
      - 8 Bacterium healis.
      - 9 Bactersum insectivhilium
      - 10. Bacterium tegumenticola
      - 11 Bacterium minutaferula
      - 12. Bacterium fulcum.
    - as Grow only on sea water media on fresh isolation.
      - 11 Bacterium sociorirum
      - 15 Bacterium immolum.
      - is nacierium immotum,
  - 3. Action on nitrates unknown.
    16. Bacterium ammoniagenes
    - 17. Bacterium minutissimum
- B. Motile in young cultures
  1 Nitrites not produced from nitrates
  - 18 Bacterium incertum
    - 19 Bacterium imperiale
- ' Motile Proteus-like growth on media
- 1 Nitrites not produced from nitrates
  - 20 Bacterium zopfii
    - 21 Bacterium zenkeri

Appendixes I and II: These list 34 additional species of Gram positive, motile or non-motile, non-spore forming, rod-shaped bacteria. See p. 600 and 612

- II Gram negative Digest cellulose. Do not digest agar A Non-motile Gelatin liquefied Chromogenic
  - 1 Milk send
- 22, Batterium idoneum.
- 22a. Bacterium liqualum

- B. Non-motile. Gelatin liquefied. Non-chromogenic.

  1. Milk acid.
- a. Ammonia produced; indole not formed.
  - 23. Bacterium udum,
- C. Non-motile. Gelatin not liquefied. Non-chromogenic. 1. Milk unchanged.
  - a. Ammonia not produced; indole not formed.
  - 2. Milk seid.
    - a. Ammonia not produced; indole not formed.
      - 25. Baclerium acidulum,
        - 26. Bacterium castigatum.
- D. Motile. Gelatin liquefied. Chromogenic.
  - 1. Milk acid.
    - a. Ammonia produced; indole is formed.

      27. Bacterium hihulum.

Appendices I to III: These list additional species of cellulose-digesting, Gram-negative, usually motile, rod-shaped bacteria. See p. 615 and 622. Also similar species that utilize bacterial polysaccharides as a sole source of carbon. See p. 623.

- III. Gram-negative. Digest agar.
  - A. Non-motile.
    - Nitrites not produced from nitrates.
      - a. Acid from glucose and other sugars
        - 28. Bacterium nenckii.
      - aa. Do not form acid from glucose.
        - 29. Bacterium polysiphoniae.
        - 20. Bacterium drobachense.
    - Action on nitrates unknown.
       a. Do not form acid from glucose.
      - 31. Bactersum delesseriac.
      - 32. Bacterium boreale.
        - 33. Bacterium ceramicola.
  - B Motile but position of flagella not given. May be either peritrichous or
    - I. Nitrites not produced from nitrates
      - 31. Bacterium rhodomelae.
    - 2. Action on nitrates unknown.
      - 35 Bacterium alginovorum.
      - 36. Bactersum fucicola.

ria See p. 627.

- IV. Gram-negative. Digest chitin.
  - A Motile but position of flagella not given.
    - Non-chromogenic.
- 37. Bactersum chitsnophilum.
- Yellow chromogenesis.
   Bacterium chitinochroma.

Appendix I: One additional species is described. See n. 632

- 1' Gram pagative Phoenhorescent bacteria A Non-motile encohacilli from sea nater
  - 1 Volicusfaction of relatin
- 39. Baeterium phosphoreum.
  - B. Motile rods from sea water Position of flarella not given 1. No growth in broth, and on coagulated blood serum or notato.
    - 40. Bacterium phosphorescens indigenus.
  - C Not stated whether motile or non-motile From diseased insect larvae.
    - 1 Vellon growth on potato
    - 41. Bactersum hemophosphoreum.

Appendix I: This includes a list of more than 40 additional so-called species of phosphorescent bacteria. See p. 631.

- VI. Gram-negative. Facultative autotrophic bacteria which seems energy from the exidation of hydrogen and utilize carbon from CO.
  - 1 You motile
    - 1. Growth shows a red chromogenesis.
  - 42 Bacterium eruthrooloeum. B. Moule with peritrichous flagella.
    - I. Yellow chromogenesis
      - 43 Racterium lentulum 41 Bactersum leucooloeum.
- 2. Ivory-colored colonies VII Gram-negative. Plant pathogens
  - A Non-motile
    - 1 Gelatin not housfied
      - 45 Racletsum alexario
  - B Motile with a nolar flacellum
    - I. Gelatin not houefied
      - a. Colonies mustard vellow on agar. 16 Raeterium tardierescens
      - b Colonies honey to Nanles vellow on agar.
        - 47 Racterium albelineans

Appendix I: This includes 19 additional species placed in Bacterium or Bacillus by their authors. All are reported to cause or to be associated with plant disease See n 679

- VIII Gram negative. Miscellaneous species
  - A Produce a pink to red chromogenesis
    - 1 Motile.
      - a Gelatin not liquefied 45 Bacterium rubefaciens
      - as Gelatin housfied
- 49 Hacterium rubidum
- 2 Non motile
  - a Gelstin not housfied
    - 30 Hacterium laterierum.

- B. Do not produce pink or red chromogenesis.
  - I. Motile.
    - a. Produce clouding in alginic acid liquid medium.

b From sea water.

51. Bacterium alginicum.

bb. From soil.

- 52. Bacterium terrestralginicum.
- sa. Action on alginic acid unknown.
  - b. Causes a disease of swans.
- Non-motile.
  - a. Causes red spot disease of carp.
    - 54. Bacterium cyprinicida.
  - aa. Causes liberation of ammonia from a mixture of horse manure and urine.

53. Bacterium eveni.

- 55. Bacterium parvulum.
- ana. Utilizes formates in a liquid medium with the formation of a reddish pellicle,
  - 56. Bacterium methylicum.

Appendix I: Miscellaneous described species of non-spore-forming bacteria placed by their authors in the genus Bacillus. See p. 643.

Appendix II: Includes anaerobic bacteria that produce methane. See p 645 Appendix III: Miscellaneous species of non-spore-forming bacteria listed but not described. See p 647.

1. Bacterium erythrogenes Lehmann and Neumann. (Bacterium lactis eruthrogenes Grotenfelt, Fortschr. d. Med., 7, 1889, 41; Bacillus lactis eruthrogenes Sternberg, Manual of Bact., 1893, 636; Lehmann and Neumann, Bakt, Diag., 1 Aufl., 2, 1896, 253; Bacillus erythrogenes Matzuschita, Bakt. Diagnostik, 1902, 220; Corynebacterium erythrogenes Kisskalt and Berend, Cent. f. Bakt., I Abt, Orig., 81, 1918, 446; Erythrobacillus erythrogenes Holland, Jour. Bact., 5, 1920, 218; Erythrobacillus (laciis) erythronenes Holland, abid; Serratia lactica Bergey et al., Manual, 1st ed., 1923, 93; Chromobacterium lactis erythrogenes Topley and Wilson, Princip Bact. and Immun., 1, 1931, 402 ) From Greek, redproducing. Micrococcus lactis erythrogenes Conn,

Esten and Stocking, Ann. Rept. Storrs (Conn.) Agr. Exp Sta., 18, 1906, 117 is stated to be allied to if not identical with the above species.

Reds: 0.3 to 0 5 by 1 0 to 14 microns, in broth often up to 4.3 microns long, occurring singly, and having rounded Non-motile. Stain nith the usual aniline dyes. Gram-positive (Lehmann and Neumann, loc. cit.).

Gelatin colonies: Small, circular, grayish, becoming vellow, sinking into the Crateriform liquefaction. medium. Yellow sediment. Medium becomes rose-colored.

frate as mouth a whitish.

surface, the nquie occourses vellow sediment. The solid portion assumes a weak rose color.

Agar stab: Moist, fairly luxuriant, yellow growth, the medium assuming a rose to wine color.

Broth: Turbid, yellow. Pellicle (Fuller and Johnson, Jour. Exp. Med., 4, 1899, 603). . ... - - letion

Sterile milk, Cascia bi-

tated, later peptonized. Reaction neu-

tral or alkaline A stratum of blood-red scrum is seen above the precipitated casein and above this a vellowish-white layer of cream. An intensive sweet odor that becomes disagreeable.

Potato: Growth rapid, spreading, gravish, later yellow. On incubation a deen golden vellow color develops after 6 to 8 days. A darkening of the medium occurs around the culture, but soon disappears; later the whole potato becomes a weak yellowish-red.

Indole not formed (Fuller and Johnson, loc cit.). Indole formed (Chester,

Manual Determ. Bact., 1901, 174). Blood serum: Liquefied (Fuller and Johnson, loc. cit.). Not liquefied (Heff-

eran, Cent. f. Bakt., II Abt., 11, 1903. 45G).

Nitrites produced from nitrates No gas from carbohydrates.

Slight II'S production (Matzuschita, loc cit.).

Red pigment insoluble in water, alcohol, ether, chloroform, and benzel. Soluble (Hefferan, loc cit., 529). Yellow piement insoluble.

Distinctive character: Milk becomes blood-red in 12 to 20 days.

Non-pathogenic for mice (Fuller and Johnson, loc. est ).

Optimum temperature 28° to 35°C Acrobic (Fuller and Johnson, loc. cit.). Facultative anaerobe (Hefferan, loc. cit . 530).

Source: Isolated from red milk by Hueppe in Wiesbaden in 1886. Isolated from feees of a child by Baginsky (Cent. [ Bakt , 6, 1889, 137), Isolated from Ohio River water by Fuller and Johnson the, cit), Isolated from Mississippi River water by Hefferen (loc. cit ). Tataroff isolated a rose fluorescent coccobacterium (Bacillus resaffuerescent Kruse, in Flügge, Die Mikroorganismen, 3 Aufl . 2, 1896, 395; Bacterium rota fluorescene Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 142) which Migula reports as identical, but which Hefferan considers atypical

Habitat: Probably widely distributed in nature.

2. Bacterium subrufum Burri and Staub. (Burri and Staub, Landwirtsch. Jahrb. d. Schweiz, 40, 1926, 1006; Serratia subrufa Bergey et al , Manual, 3rd ed . 1930, 123.) From Latin aub. somewhat and rufus, red.

This organism is stated to be closely related to or possibly identical with Bacterium eruthrogenes,

3. Bacterium linens Weigmann. (Organismus IX, Wolff, Milchwirt, Zent., 5, 1909, 145, Weigmann, in Wolff, Cent. f Bakt., II Abt., 28, 1910, 422, and in Weigmann, Mykologie der Milch, 62, 1911.220.) From Latin, daubing, smearing, or spreading over.

Also see Strinfatt. Milchwirt. Forsch., 9, 1930, 7; Kelly, Jour, Dairy Sei., 20, 1937, 230; Albert, Long and Hammer, Iona Agr. Exp. Sta. Res. Bul.

328, 1914.

Rods: Average 062 by 2.5 microns when grown 1 to 2 days on tryptone glucose extract agar. Non-motile (Wolff). Gram-positive (Kelly, loc. cit ). Gelatin colonies. At 18°C punctiform

at first; after 12 days about 1 mm in diameter, compact, circular, shiny, brownish-yellow to red-brown

faction.

Gelatin stab: At 21°C erateriform liquefaction, becoming infundibu'iform on extended incubation. Blate of liquefaction varies considerably with different cultures, some completing it in 15 days, others not completing it even on long insubation.

Agar colonies: On tryptone glucoso extract agar at 21°C after 1 to 2 days. colonies convex, glustening, entire and cream-colored, becoming brown on extended incubation; diameters 2 to 5 mm. On special cheese agar with incubation in oxygen, luxuriant growth, the color becoming bright orange to reddehbrown in 4 or 5 days

Agar stab: Heavy surface growth on tryptone glucose extract agar at 21°C with no growth along the line of inoculation

Agar slant: On tryptone glucose extract agar at 21°C after 2 days growth abundant, glistening, filiform, non-viscid and cream-colored. After extended incubation the color usually is brown. On special cheese agar in an atmosphere of oxygen the growth is bright grange to

reddish-brown in 4 or 5 days.

Broth: Turbidity and sediment.

Potato. At 21°C after 5 days, growth is scanty, smooth, glistening, and varies in color from grayish to brownish-orange.

Litmus milk- At 21°C the changes are very slow. After 6 or 7 days the reaction becomes alkaline and a yellow sediment appears. After approximately 10 days some digestion is evident, complete digestion generally requiring several weeks to over a month. A distinct ammoniacal odor, more or less objectionable, produced in old cultures No coagulation. Ropiness often produced on extended inenhation.

Indole not produced.

Nitrites produced from nitrates Methyl red and Voges Proskauer reac-

tions negative.

Hydrogen sulfide produced in broth
and on agar by some cultures but not
by others.

Natural fats not hydrolyzed

No acid or gas from arabinose, devtrin, glucose, duleitol, galactose, inulin, lactose, fructose, maltose, mannitol, raffinose, rhamnose, salicin, sorbitol, sucrose or xvlose.

Ethyl, propyl, butyl and amyl alcohols oxidized largely to corresponding acids; hexyl and heptyl alcohols attacked much less actively

Catalase rapidly produced in or on various media.

Aerobie.

Growth temperatures. Growth at 8° and 37°C but not at 45°C, with the optimum at about 21°C.

Heat resistance low, cultures being killed at 62.8°C in a few minutes. Growth in the pH range 6 0 to 9.8; no

growth at pH 5.0 or below.

rowth at pH 5.0 or below. Salt tolerant, cultures growing readily

in a concentration of 15 per cent salt in broth or skim milk, with certain cultures apparently capable of growing somewhat in much higher concentrations.

Closely related to or identical with Bacterium erythrogenes Lehmann and

Neumann

Source: Originally isolated by Wolff from the surface flora of various soft cheeses.

Habitat: Widely distributed in and especially on the surface of dairy products including blue, brick, camembert, limburger, oka and choddar cheeses, butter, milk and cream. Also found in various feeds including grains, slage, green plants, hay and straw, and in water, soil, manure, and air.

4. Bacterium mycoides (Grotenfelt) Migula. (Bacterium mycoides roseum Grotenfelt, Fortschr. d. Med., 7, 1889, 46; Bacillus mycoides roseus Sternberg, Manual of Bact., 1893, 640; Migula Ryst. d Bakt., 2, 1900, 482; Bacillus mycoides-roseus Holland, Jour. Bact., 6, 1920, 210; Erythrobacillus mycoides-roseus Holland, bbid.; Serralia rosea Bergey et al., Manual, 1st ed., 1923, 96; Chromobacterium mycoides roseum Fopley and Wilson, Princip. of Bact. and Immun, 1, 1931, 402.) From Greek mydes, fungs and eudos, form.

Rods: Non-motile, Gram-positive.

Liquefaction

Gelatin stab: Rapid liquefaction. Red pellicle. Red sediment.

Colonies composed of interlacing filaments (Crookshank, Textb of Bact. and Inf Dis., 1900, 524).

Agar stab: Red color produced if grown in dark; a white color in presence of light. Optimum temperature: Room temperature.

Pigment soluble in water.

Distinctive characters. Morphologrally like the anthrax bacillus. Appearance in gelatin Production of a brilliant rose color when grown in the dark; colonies grown in the light are white, but they assume the red color if developed further in the dark.

Source Isolated from Wiesbaden soil

by Scholl

Habitat: Unknown.

Note. It has been claimed that this or a similar organism forms spores (Matzuschita, Baet Diiac, 1902, 163; Perlberger, Cent f. Bakt, II Abt, 62; 1924, S). However cultures of Scholl's organism received from the Kral collection by Helferan (Cent f Bakt, II Abt, 11, 1903, 455) and by Breed in 1926 (personal communication) did not form spores. These cultures produced nitrates from nitrates and failed to liquefy gelatin

5 Bacterium mutabile Steinhaus (Jour Bact., 42, 1941, 775) From Latin mutabilis, changeable

Short rods On agar, 0.7 to 0.9 by 1.0 to 2.0 micross. In fluid media, such as typtophane broth, pleomorphic, bi-zarre forms frequently appearing slightly branched Non-motile. Gram positive

Gelatin stab. Very slow liquefaction. Again colonies: Cream to yellow, our cular, smooth, glistening, on aque

Broth Moderate turbidity, slight sedi-

ment
Litmus milk Alkaline, soft curd, slow
peptonization

Indole not produced

Hydrogen sulfide not produced Nitrates produced from nitrates

Starch not by drolyzed tilucose, lactose, sucrose and maltuse not fermented

Verobie

Source From the alimentary tract of

the lyreman cicada, Tibicen linnei

Habitat: Unknown

6 Bacterium qualis Steinhaus. (Jour. Bact., 42, 1941, 774.) From Latin qualis. of what kind.

Short rods. Very short on solid media, frequently ellipsoidal in shape. In fluid media. 0 5 to 0.7 by 1.4 to 2.2 microns, occurring singly. Non-motile. Grammoutive

Gelatin stab. Liquefaction.

Agar colonies: Small (1 mm), white, glistening, transparent, circular, entire.

Agar slant. Filiform, smooth, glistening.

Broth: Almost clear; slight turbidity in serum and glucose broth.

Litmus milk. No change.

Indole not produced Hydrogen sulfide not produced.

Slight production of nitrites from hi-

Starch not hydrolyzed

Acid from glucose, sucrose and maltose Lactose not fermented.

Source From the alimentary tract of

Source From the alimentary tract of the tarnished plant bug, Lygus proten-

Habitat Unknown

7 Bacterium racemosum Zettnow (Zettnow, Cent I Bakt, I Abt, Orig, 77, 1915, 200, Zetinovia racemosa Enderlem, Bakt Cyclogenie, Berlin, 1925, 230; Flacobacterium racemosum Bergey et al., Manual, 1st ed., 1923, 115) From Latin racemosus, Intanching

Filaments 0.5 to 0.8 by 10 to 12 mierons. Branching forms found. Nonmotile. Gram positive.

Gelatin colonies. White, circular, rolt, granular, brownish, entire.

Gelatin stab White surface growth.

Agar elant Light yellow, limited growth

Broth: Turbid

Litmus milk: Coagulated, becoming alkalina

Potato. Dirty-vellowish. limited streak.

Indole not formed.

Nitrites not produced from nitrates. Aerobic, facultative.

Ontinum temperature 20°C.

This species is selected as the type species for the genus Zettnowia Enderlein (loc. cit.).

Source: Contamination on agar plate. Habitat: Unknown.

8. Bacterium healii Buchanan and Hammer, (Buchanan and Hammer, Iowa Agr. Exp. Sta. Research Bull. 22. 1915, 249; Escherichia healii Bergey et al., Manual, 1st ed., 1923, 200; Achromobacter healts Bergey et al., Manual. 2nd ed., 1925, 157.)

Rods: 0.5 to 0 7 by 2.2 to 12.9 microns. occurring singly and in short chains. Non-motile. Gram-positive.

Gelatin stab: Stratiform liquefaction.

Villous growth in stab.

Agar colonies: Large, white, rhizoid. Agar slant: White, hard growth, with no tendency to stringiness.

Broth: Gray pellicle and sediment. Litmus milk Slightly acid, becoming

slimy, coagulated, peptonized. Potato: Heavy, white, glistening growth.

Indole not formed

Nitrites not produced from nitrates. Acid without gas from glucose, fruetose, maltose, sucrose, salicin and starch.

No acid from mannitol, lactose, raffinose or inulin Aerobic, facultative

Optimum temperature 22°C Source: Slimy milk. Habitat: Unknown

 Bacterium insectiphilium Steinhaus. (Jour. Bact., 42, 1941, 777.) From M. L. insect, insect and Greek philos, loving.

Rods, 0.8 to 1.2 by 1.0 to 2.8 microns, occurring singly At times appearing almost as cocci or coccobacilli. Nonmotile. Gram-positive.

·Gelatin stab: Liquefaction.

Agar colonies: Light greenish-yellow, circular, entire, raised, glistening, smooth, opaque.

Agar slant: Filiform, raised, smooth. glistening, opaque growth.

Broth: Moderate turbidity, slight viscid sediment.

Litmus milk: Alkaline, peptonization, and slow reduction.

Potato: Greenish-yellow, thick, moist growth.

Indole not produced.

Nitrites not produced from nitrates. Hydrogen sulfide not produced. Starch slightly hydrolyzed.

No action on the following carbohydrates: Glucose, lactose, sucrose, maltose, fructose, mannitol, galactose, arabinose, xylose, dextrin, salicin, rhamnose, raffinose, trehalose, sorbitol, inulia, dulcitol, glycerol, adonitol, mannose.

Aerobic.

Source: From the body wall of the bagworm, Thursdoplerux ephemeraeformis Haw.

Habitat: Unknown.

10. Bacterium tegumenticola Stein-(Jour. Bact., 42, 1941, 775.) From Latin tegumentum, cover, skin and cola, dweller.

Small rods: 0.5 to 0 8 by 1.0 to 1.5 microns. Have a tendency to be ellipsoidal on solid media. Non-motile. Gram-

positive. Gelatin stab: Generally no liquefac-

Variable. tion Agar colonies: Tiny (1 mm), white,

convex, glistening, circular, entire Agar slant: Filiform, glistening, grayish-white growth.

Broth: Slight turbidity; sediment.

Litmus milk: No change. Indole not produced

Hydrogen sulfide not produced. Nitrites not produced from nitrates.

Starch not hydrolyzed Acid slowly produced from glucose and maltose. Acid from sucrose Lac-

Source: From the integument of the bed-bug, Cimex lectularius L.

Habitat: Unknown.

11. Batterium minutaferula Steinhaus. (Jour Bact., 42, 1911, 778.) From Latin,

Very small rods: 0.4 to 0 9 by 0 7 to 1 0 micron, occurring singly Non-motile Gram positive.

Gelatin stab: No liquefaction.

Agar colonies: Colorless to faint gray, circular, smooth, entire, glistening

Agar slant. Very thin, transparent,

Broth, Slight turbidity and sediment Litmus milk. No change at first; sheltly acid after one week

Indole not produced.

Hydrogen sulfide not produced

Nitrites not produced from nitrates Starch not hydrolyzed,

Acid from glucose after 4 days Slight acid from sucrose Lactose and maltose not fermented

Aerobie

Source: From triturated specimen of the mud diuber wasp, Secliphron ce mentarium Dru.

Habitat, Unknown.

12 Basterium fulvum (Zummermann). Chester (Bacillas Juleus Zummermann). Bakt unserer Trink- u Nutrakseer, Chemartz, J. 1830, 44, Chester, Ann. Rept Del Col. Agr. Exp Sta. 9, 1847, 107, Firnéndernum fulcum Bergey et al. Manud. 18 et el., 1923, 115). From Latin fulcus. dull yellom.
Roda 0 8h. 09 to 13 microns, occur-

ring singly, in pairs and in chains. Not motile. Gram positive. Gelatin, colories. Circular, conve-

Gelatin colories Circular, convex,

Gelatin stab: Conver, rellish-yellow sorface growth. Good growth in stabatos hypefaction.

Agar slant Orange rel, glistening

Broth: Turbid with yellow sediment. Litmus lactose broth: Acid, or acid then alkaline (Dyar, Ann. N. Y. Acad. Sci. 8, 1835, 2009)

Potato: Slowly spreading, yellowish,

Indole formed (Dyar, loc. cit.).

Nitrites not produced from nitrates (Bergey).

Aerobic, facultative.

Optimum temperature 30°C.

Source: From Chemnitz and Döbeln tap water (Zimmermann) From dust and water (Dyar).

Habitat Water.

13 Bacterium marinopiscosus ZoBell and Upham. (Bull Scripps Inst Oceanography, La Jolla, 5, 1911, 253.) From Latin marinus, pertaining to the sea, and piscosus, fish.

Rods: 1.2 to 16 by 2.0 to 4.7 microns, with rounded ends, show granular staining, occurring singly, in purs and long chains. Non-motile. Gram-positive, but many cells tend to decolorize leaving Grem positive granules

All differential media except the freshwater broth, litmus milk, and potato were prepared with sea water. Gelatin coloniest Gray, circular, con-

vex, 1 mm. No pigment

Gelatin stab: Laquefaction napiform, becoming crateriform to stratiform with age. Complete in 50 days.

Agar colonies 2 to 4 mm, circular, conrex, entire, smooth, irregular edge.

Agarshant: Luxuriant, beided, glistening, butyrous growth with no pigment Serwater broth. No turbidity, abundant floculent sediment, slight 8 irface

Fresh-water broth: Good growth

Litmin in it. Decolorized, neutral, top peptonized.

Potato Heavy, whate, ruse i, muroid, dall gravith. Potato darkene i. falide not forme i.

Natrates not produced from natrates, Acidbut no gas from glaces and mannitol. No acid from maltose, lactose, sucrose, glycerol, xylose or salicin.

Starch is hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from peptone but not from urea.

Casein is digested.

Fats are not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C, Source: Found on the skin of marine fish.

Habitat: Not known from other sources.

14. Bacterium sociovivum ZoBell and Upham. (Bull. Scripps Inst. Oceanography, La Jolla, 6, 1944, 269.) From Latin socius, associate and vivum, to live.

Rods. 0.5 to 0 8 by 3.0 to 4 0 microns, with rounded ends, occurring singly, in pairs, and chains. Non-motile. Grampositive but tends to destain, leaving Gram-positive cell wall and granules.

All differential media except the freshwater broth, litmus milk and potato were prepared with sea water.

Gelatin colonies: Irregular, sunken, filamentous margin, grayish-white.

Gelatin stab · Crateriform liquefaction becoming stratiform.

Agar colonies. 2 to 4 mm. circular, convex, smooth, entire, darker center. Agar slant: Luxuriant, beaded, glis-

tening, butyrous growth with no pigment. Sea-water broth. No pellicle, no tur-

Sea-water broth. No pellicle, no turbidity, heavy flocculent sediment

Fresh-water broth Fair growth. Litmus milk Decolorized, neutral, completely peptonized in 20 days.

Potato Abundant, dull, light cream-

colored growth. Potato darkened.
Indole not formed

Indole not formed

Nitrites not produced from nitrates. Acid but no gas from glucose, maltose, and mannitol. No acid from glycerol, lactose, sucrose, or salicin.

Starch is hydrolyzed

Hydrogen sulfide not formed

Ammonia produced from peptone but not from ures.

Casein is digested.

Fats not hydrolyzed.

Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Found associated with sedentary organisms in the sea.

Habitat: Commonly found on submerged surfaces and on sessile diatoms in sea water.

15. Bacterium immotum ZoBell and Upham. (Bull. Scripps Inst. Oceanography, 5, 1944, 271.) From Latin, meaning immobile or stationary.

Rods: 08 by 3.1 to 8.6 microns, with rounded ends, occurring singly, in pairs, and long chains. Non-motile. Grampositive but tend to destain leaving Gram-positive outline and granules.

All differential media except the freshwater broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: Small, circular, raised, gray, slowly digest gelatin.

Gelatin stab: Crateriform liquelaction becoming infundibuliform. Beaded growth along line of stab. No pigment Agar colonies: 1 to 2 mm, circular, convev, smooth, lobate margin, darker

centers.

Agar slant: Luxuriant, glistening, echinulate, mucoid growth with no pigment.

Sca-water broth: No pellicle, moderate turbidity, abundant, flocculent sediment.

Fresh-water broth: Scanty growth. Litmus milk: Decolorized, neutral,

partly peptonized in 20 days.

Potato: Luxuriant, mucoid, creamy

growth which darkens potato.

Indole not formed.

Nitrites not produced from nitrates. Acid but no gas from glucose, maltose, xylose, and mannitol. No acid from

glycerol, lactose, sucrose, or salicia. Starch is hydrolyzed.

Hydrogen sulfide not formed.

Ammonia produced from pentone but not from uses

Cascin is directed.

Fats not hydrolyzed.

Aerobic facultative

Ontimum temperature 20° to 25°C Source: Found associated with marine sedentary organisms.

Habitate Not Inoun from other ROUTECES

16. Bacterium ammontagenes Cooke and Keith (Cooke and Keith, Jour Bact . 15, 1927. 315: Alcoligenes ammontagenes Bergey et al., Manual, 3rd ed., 1930, 367.) From M. L. ammania and Latin genero, develop

Rods with rounded ends, 08 by 14 to 1.7 microns, occurring singly. Non-

motile. Gram-positive.

Gelatin stah: No honefaction Agar colonies: Circular, flat, smooth, entire, grav.

Agar slant: Growth moderate, smooth, flat, opaque, glistening, butyrous, amorphous.

Broth: Moderate turbidity, with flocculent sediment.

Litmus milk: Slightly alkaline

Indole not formed.

No action on earbohydrates Blood serum not housefied.

Urea is fermented forming ammonia

Acrobic, facultative.

Optimum temperature 30°C.

Source: From feees of infants

Habitat Presumably widely tributed in putrelying materials

17. Bacterium minutissimum Migula (Bacillus pyogenes minutissimus Kruse, in Flücze, Die Mikroorganismen, 3 Aufl . 2, 1896, 447; Racterium pyogenes minufissimus Chester, Ann Rept. Del. Col Agr Exp. Sta., 9, 1897, 89; Migula, Syst d. Bakt., 2, 1900, 418, Eberthella minutissima Bergey et al , Manual, 1st ed. 1923, 229; Shigella minutissima Bergey et al , Mahual, 3rd ed , 1970, From Latin, smallest.

Description from Kruse (loc. cit) Description not different from that of Bacillus tenuis sputigenes Pansini, according to Chester (Ann. Rept. Del. Col. Agr. Exp. Sta. 9 1897, 891.

Rods: 05 by 10 mieron, occurring singly and in mirs You-motile

Gram-positive.

Gelatin stah: No liquefaction Vollowish growth spreading slightly on mirfaco

Growth on agar and blood serum is not characteristic

Acid but no gay from glucose and lactose.

No characteristic odor.

Not nathogenic for mice and rabbits. Acrobic, facultative.

Ontimum temperature 37°C. Source: Isolated from a facial absense

Habitat. Not known from other SOUTCES

18 Bacterlum Incertum Steinbaus (Jour. Bact . 42, 1941, 776 ) From Latin incertus uncertain.

Short rods 05 to 0.8 by 1.0 to 15 microns, occurring singly and occasionally in pairs. Young cultures motile, after 45 hours generally non-motile Gram-positive; after 18 hours many cells become Gram negative

Gelatin stab: No linuefaction.

Agar colonies. Tiny, grayish-white, smooth, almost transparent. Does not grow well on nutrient agar. North's gelatin chocolate agar slant;

Filiform, thin, transporent greath Brown color of chocolate medium changes to sellowish-green.

Blood agar Alpha hemolysis at first: after three days beta hemolysis.

Broth. Almost clear, very slight eronth.

Litmus rulk: No change.

Indole not produced

Hydrogen salfile not produced Nitrates not produced from nitrates

Starch not hadrolyzed

And but no gas from glucose, retrose,

fructose, mannose, and maltose. No fermentation of lactose, rhamnose, galactose, mannitol, dulcitol, inositol, or sorbitol.

Voges-Proskauer test: Negative.

Microaerophilic.

Source: From the ovaries of the lyreman cleada, Tibicen linnel Smith and Grossbeck.

Habitat: Unknown.

19. Bacterlum imperiale Steinhaus, (Jour. Bact., 42, 1941, 777.) From Latin imperialis, referring to the imperial moth.

Small rods: 0.5 to 0.8 by 1.0 to 1.7 microns, occurring singly and in pairs. A few cells motile in young cultures. Gram-positive.

Gelatin stab: No liquefaction.
Agar colonies: Circular, entire, almost

translucent, pinkish-orange to yellow pigment.

Agar slant: Filiform, glistening.

Agar slant: Filiform, glistening, opaque growth.

Broth: Slight to moderate turbidity; slight sediment.

Litmus milk. No change at first, later slightly acid. Potato, Heavy, glistening, moist

growth, reddish to yellowish-orange.
Indole not produced.

Hydrogen sulfide not produced. Nitrates not produced from nitrates.

Starch not hydrolyzed.

Acid but no gas from glucose, sucrose, maltose, fructose, mannitol, galactose, rathinose, xylose, salicin, raffinose, tre-halose, sorbitol, mannese, adonitol, esculin, and slight acid from lactose and del-trin. Inulin, dulcitol, glycerol, rhamnose, adonitol, and inositol not

fermented. Aerobic.

Source From the alimentary tract of the imperial moth, Eacles imperialis Dru.

Habitat · Unknown.

 Bacterlum zopfil Kurth. (Kurth, Bericht. d. deutsch. Botan. Gesellschaft, 1, 1833, 97; Kurthia zopfii Trevisan, Atti della Accad. Fisio-Medico-Statistica in Milano, Ser. 4, 5, 1835, 92; Hellishbaterium zopfii Escherich, Münch. med. Wehnschr., 53, 1856, 2, quoted from Enlows, U. S. Hygienic Lab. Bull. 121, 1920, 47; Bacterium (Proteus) zopfii Chester, Ann. Rept. Del. Col. Agr. Exp. Stat., 9, 1807, 103; Bacillus zopfii Migula, Syst. d. Bakt., 2, 1900, 815; Zopfius zopfii Wenner and Rettger, Jour. Bact., 4, 1919, 334.) Named for W. Zopf, German botanist.

This is the type species of the genus Kurthia Trevisan. (Trevisan, loc. cit.; Zopfius Wenner and Rettger, Jour. Bact., 4, 1919, 334.)

Rods: 0.8 by 3.5 microns, with rounded ends, occurring in long curved chains. Motile with peritrichous flagella. Gram-nositive.

Gelatin colonics: Radiate, filamentous, gray.

Gelatin stah: Arbayesent, gray th in

Gelatin stab: Arborescent growth in stab. No liquefaction.

Agar colonies: Fimbriate.

Agar slant: Spreading, gray, fimbriate growth.

Broth: Slow, moderate growth.

Litmus milk; No change.

Potato: Moderate, gray growth; medium becoming dark,

ium becoming dark No H.S produced.

Indole not formed.

Nitrites not produced from nitrates Aerobic, facultative.

Optimum temperature 25° to 30°C. Habitat: Decomposing materials.

21. Bacterium zenkeri (Hauser) Chester. (Profeus zenkert Hauser, Ueber Faulnissbakterien, 1885; Bucillus zenkeri Trevisan, I generi ele specie delle Batteriacet, 1889, 17; Chester, Ann. Rept Del, Col. Agr. Exp. Sta., 9, 1897, 103; Zopfius zenkeri Wenner and Rettger, Jour. Bact., 4, 1919, 334; Bacillus proteus-zenkeri Holland, Jour. Bact., 6, 1920, 220; Kurthia zenkeri Bergey et al., Manual, 2ad ed., 1925, 215.) Named for K. Zenker, German pathologist.

Rods, 0.65 by 1.6 to 2.3 microns, occurring in pairs and in chans. Motile with peritrichous flagella. Gram-positive.

Gelatin colonies. Feathery, with filaments extending in all directions.

Gelatin stab: Surface growth like colonies. No arborescent growth in stab No liquefaction

Agar colonies: Thin, filamentous, spreading, grayish.

Agar slant: Thin, bluish-gray, filamentous growth

Broth: Slightly turbed, with gray sediment.

Litmus milk: No change. Potato. Barely visible, yellowish-

gray, glistening growth.

Indole not formed.
Nitrites not produced from nitrates

No II S formed

Acrobic, facultative.

Optimum temperature 30°C. Habitat: Decomposing materials

Note: Wenner and Rettger, loc cil, consider the last two species to be identical.

Appendix I: The following Gram-positive, motile species may belong with the above group. All have been placed at one time of another in the genus Ackromobacter or in the genus Flarobactersum

Achromobacter lipolyticum (Huss)
 Bergey et al. (Bactedium lipolyticum
 Huss, Cent. I. Bakt., II. Mit. 29, 1905,
 Bergey et al., Manual, 2nd ed.
 1925 Lib.) From Greek, Intelissolving
 Small, Coal ends. 32, 60, 65, 60, 72, 60

Small, oral role, 03 to 05 by 07 to 14 micross Motile, possessing peritrichous flagella. Gram-positive

Gelatin colonies Circular, grassish to transparent with irregular margin Gelatin stab Infundibuliform lique-

fretien
Agar colonies Growth circular, gray,

smooth, glerening, with entire margin Broth Turbid with granular sediment Litture milk Congulated, poptomized, becoming alkaline Potato: Moist, glistening, grayish grouth.

Indole is formed.

Acid from glucose, sucrose, raffinose, sylose, mannitol and glycerol.

Fats are split in milk, giving rise to a rancid odor and a bitter taste

Aerobic, facultative, Optimum temperature 35°C.

Source. From the udder of a cow giving abnormal milk.

Habitat Milk

Achromobacter stearophliam (Weinzitl) Bergey et al. (Bazillus stearophilus Weinzitl, Jour Med. Res., 59, 1919, 401, Bergey et al., Manual, 1st ed., 1923, 145)

Rods, 0.8 by 50 microns, occurring sangle. Motile, Gram-positive.

ungs). Stottie. Gram-positive.
Gelatin colonies. Scanty development.
Pumplin gelatin stab. Filiform growth

m stab. No liquefaction. Pumpkin sgar colonica Small, smooth,

eonvex, gray, entire Pumpkin juice: Slightly turbid.

Pumplin milk Acid, coagulated. Potato Slight, smooth, gray, glistening, fiblorm growth.

Indole not formed

Nitrites not produced from nitrates, No send from carbohydrate media. Starch from pumplin by drolyzed.

Aembie, facultative

Optimum temperature 20°C, Source Canned pumpkin

Habitat Unknown

3 Achromobacter sulfureum Bergey et al. (Bakt. 1 Rubentschick, Cent. 1. Bakt., H. Mn., 72, 1927, 123; Bergey et al., Manuel. 3rd et., 1939, 220 J. Rede 0.7 to 0.8 h. 1.7 to 2.2 micrors.

occurring singly and in pairs. Moule

Gelotin etab Sacente liquefection.

Agareolonies Circuler, grayerballite, flat, l'omogereous

Agar slant Fillorm, grayuloulite, smooth, homogeneous growth Metallic luster. Broth: Turbid.

Litmus milk: Peptonized.

Potato: Yellowish-brown layer. Indole not formed.

Nitrites produced from nitrates with gas formation.

Hydrogen sulfide formed.

Ammonia formed.

Urea is attacked.

Methylene blue reduced. Aerobic, facultative

Optimum temperature 30° to 33°C. Can grow at 0°C.

Source: Sewage filter beds.

Habitat: Putrefving materials.

NOTE: See Pseudomonas urcase Bergey et al, for another motile. Gram-nositive organism described by Rubentschick (Bakt, 3) from the same source,

4. Achromobacter aerophilum (Rubentschick) Bergey et al. (Urobacterium aerophilum Rubentschick, Cent f. Bakt ... II Abt., 64, 1925, 168; Bergey et al., Manual, 3rd ed., 1930, 224.)

Rods: 0.75 to 0.85 by 2.0 to 4 5 microns, occurring singly, in pairs, and in chains, Motile. Gram-positive.

Urea gelatin colonies: Small, circular,

dirty-gray, entire. Urea gelatin stab. No liquefaction.

Urea agar colonies: Circular, grayish, smooth

Urea agar slant: Dirty-gray, glistening to dry growth.

Urea broth: Turbid.

Urea milk: Unchanged

Urea potato Slight, grayish-white streak.

Indole not formed

Nitrites produced from nitrates HtS not formed

Ammonia not formed.

Aerobic, facultative. Source: Sewage slime.

Habitat: Putrefying materials.

5 Achromobacter citrophilum (Rubentschick) Bergey et al. (Urobacterium

citrophilum Rubentschick, Cent f. Bakt , II Abt , 64, 1925, 168; 66, 1926, 161; 67, 1926, 167; 68, 1926, 327; Bergey et al., Manual, 3rd ed., 1930, 224.)

Rods: 0.75 to 0.85 by 2.5 to 6.0 microns. occurring singly and in pairs. Motile. Gram-positive.

Urea gelatin colonies: Small, gravishwhite, smooth, undulate.

Urea gelatin stab: No liquefaction. Urea agar slant: Filiform, gravish-

white, thin, dry growth. Urea broth: Turbid.

Urea milk: Unchanged.

Urea potato: Dirty-gray, thin streak. Indole not formed.

Nitrites produced from nitrates Hydrogen sulfide not formed.

Ammonia not formed. Can derive oxygen from sodium ci-

trate. Acrobic, facultative. Optimum temperature 30°C.

Source: Sewage slime. Habitat: Putrefying materials.

6. Flavobacterlum sulfureum Bergey et al. (Bacterium vunctans sulfureum Zettnow, Cent. f. Bakt., I Abt., Orig., 77, 1916, 222; Bergev et al., Manual, 1st

ed., 1923, 103.) Rods: 0.5 to 0.7 by 0.7 to 1.5 microns. Motile, possessing peritrichous flagells. Gram-positive.

Gelatin colonies: Very small, barely becoming brownish-yellow, visible. granular.

Gelatin stab: Spreading growth on the surface only. Later crateriform liquefaction.

Agar slant: Sulfur-yellow growth

Broth: Turbid. Litmus milk: Alkaline, peptonized,

vellow. Potato: Sulfur-yellow streak.

Indole not formed.

Nitrites not produced from nitrates. Blood serum: Sulfur-yellow growth, Partial liquefaction.

No acid from glucose. Aerobic, facultative

Optimum temperature 25°C.

Courses ti-Habitat . Hal nown

7 Flavohacterium acetylicum Levine and Soppeland (Bull 77, Engineering Evn Sta Jona State Agricultural Colloge 1926 46 ). From the chemical term eccts 1

Rods: 0.9 by 1.1 microns, with rounded ends occurring singly and in pairs

tile Gram-nositive.

Gelatin stab: Stratiform liquefaction Ager colonies. Irregular in form, vellow smooth, flat amorphous, entire

Agar slant: Abundant, echinulate growth flat neach vellow, smooth and

buts rous. Broth Ring growth on surface

but with scant sediment. Litmus milk. Slight acidity, with granular curd. Pentonization. Litmus

roducod Potnto Moderate, orange growth

Indole not formed

Nitrites not produced from nitrates Starch hydrolyzed. Blood serum houefied,

Acid from glucose with formation of acetylmethylcarbinol.

Acrobic, facultative Optimum temperature 22°C

Source: From skimmed milk Habitat Unknown

a Flavohacterium fuscum (Zimmermann) Berrey et al. (Bacillus fuscus Zimmermann, Bakt, unserer Trink- und Nutzwässer, Chemnitz, I, 1990, 70, not Bacillus fuscus Hügge, Die Mikroorganismen, 2 Aufl., 1886, 200, Bacterium fuscus Chester, Ann Rept Del Col-Agr Lap Sta., 9, 1897, 111; Bergey et al . Manual, lat ed., 1923, 113, Chromobac terrum fuseum Topley and Wilson, Princ Bact and Immun . 1, 1931, 405 ) From Latin fuscus, tawny

Rods 0.6 by 1.5 microns, occurring Non-motile Gram positive

Gelatin colonies Small, with brownish center and rellowish border

Goldtin stab: Grav. fileform growth in stab. Slow crateriform liquefaction.

Agar colonies: Circular, pale vellow smooth, slightly convey, entire

Agar slant : Growth greenish vellow nlumose, smooth, raised undulate

Broth: Turbid, with pellicle and sediment

Litmus milk: Shehtly acid becoming alkaline, with vellow ring.

Potato: Thick moist chrome-vellow streak.

Indole not formed

Nitrites produced from pitrates Aerobic, facultative.

Ontimum temperature 30°C

Source: From Zwonitz River water Habitat . Water

Sa. Bacterium fuscum limefactens (Dyar) Chester. (Bacillus fuscus liques factors Dyar, Ann. N. Y. Acad. Sci. 8. 1895, 375, Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 108.) Received from the Kral collection labeled Bacillus fuscus; also from air. Differs from the above only in liquelying gelatin more slowly and completely.

9 Flavobacterium maria Harrison (Canadian Jour Research, 1, 1929, 232 ) From Latin mare, sea.

Rods 07 to 0.8 by 10 to 12 microns. occurring singly and in pairs At 37°C Luccoud. Non-motile. Encapsulated Gram-positive.

Gelatin colonies: Punctiform, red orange, granular, entire.

Gelatin stab Red-orange surface growth, filiform growth in stab No inquelaction

Agar colonies Circular, orange yellos, smooth, glistening, convex

Agar slant Growth mederate, orangevellow, becoming cadmium grange to red-orange, spreading, glistening

Broth Clear with orange pellicle and rediment Litmus milk At first faintly alkaling.

becoming faintly acid with orange sech ment.

Potato Scant growth

Gelatin stab: Moderate, yellowish growth. Slight napiform liquefaction.

Agar colonies: Circular, convex, soft, becoming brittle, grayish, granular, entire.

Agar slant: Scant, yellowish-white growth, becoming distinctly yellow.

Ammonia cellulose agar: Enzymatic zone shows a diameter of 2 to 3 mm at the end of 30 days,

Peptone cellulose agar: Enzymatic zone shows a diameter of 1.5 to 20 mm at the end of 30 days.

Broth: Turbid,

Filter paper broth: Paper reduced to thin, limp sheet which falls apart on slight agitation at end of 15 days.

Litmus milk: Acid, not digested. Potato: Abundant, moist, glistening, grayish-white growth, becoming distinctly vellow.

Indole not formed.

Nitrites produced from nitrates.
Ammonia not produced.

Acid from glucose, maltose, lactose, starch and glycerol.

Aerobic, facultative.

Optimum temperature 20°C. Source: Soil from California.

Habitat: Soil

23. Bacterium udum Kellerman et al. (Kellerman, McBeth, Scales and Smith, Cent. f. Bakt., II Abt., 39, 1013, 514; Cellulomonas vida Bergey et al., Manual, 1st ed., 1923, 166; Proteus cellulomonas var. Proteus udva Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 72.) From Latin udus growing in marsby ground.
Rods: 05 by 15 microns. Non-mo-

tile. Gram-negative.

Gelatin stab: Liquefaction.

Agar slant: Luxuriant, faintly yellowish growth.

Cellulose agar. Enzymatic zone 0.5 mm wide. Broth: Turbid.

Litmus milk Acid.
Potato: Good growth
Indole not formed.
Nitrites produced from nitrates.

Ammonia is produced.

Acid from glucose, fructose, arabinose, xylose, maltose, lactose, sucrose, dextria and starch.

Aerobic, facultative.

Optimum temperature 20°C.

Source: Compost from Arlington, Va. Habitat: Soil.

24. Bacterium lucrosum McBeth. (McBeth, Soil Science, 1, 1916, 461; Cellulomonas lucrosa Bergey et al., Manual, 1st ed., 1923, 167.) From Latin lucrosus, lucrative.

Rods; 0.4 by 1.3 microns, Non-mo-

tile. Gram-negative.

Gelatin stab: No growth.
Agar colonies: Circular, convex, semi-

transparent, granular, entire.

Agar slant: Moderate, flat, grayish-

white growth, becoming somewhat indescent.

Ammonia cellulose agar: On crowded

plate, the colonies show an enzymatic zone of 1 mm or more.

Peptone cellulose agar: Enzymatic zone 2 to 3 mm wide in 25 days.

Broth: Turbid.

Filter paper broth: Paper is reduced to a grayish-white pulpy mass whose fibers separate on slight agitation.

Litmus milk: No change.

Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates.

Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch and mannitol.

Aerobic, facultative.

Optimum temperature 20°C.

Source: Soil from California. Habitat. Soil.

 Bacterium acidulum Kellerman et al. (Kellerman, KeBeth, Scales and Smith, Cent. f. Bakt., II Abt., 32, 1013, 513; Cellulomonas acidula Bergey et al., Manual, 1st ed., 1923, 167.) From Latin acidus. acid.

Rods: 0 3 by 1.0 micron Non-motile.

Gram-negative.

Gelatin stab: No linuefaction.

Agar slant: Slight, gravish growth. Cellulose agar: Enzymatic zone 0 5 to I mm in width.

Broth Clear

Litmus milk: Acid. Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates Ammonia not produced

Acid from glucose, maltose, lactore and sucrose. None from givcerol or mannitol

Starch not hydrolyzed

Aerobic.

Optimum temperature 20°C.

Source, Soil from Hah.

Habitate Soil

26 Bacterium castigatum McBeth (McBeth, Soil Science, 1, 1916, 458; Cellulomonas castigata Bergey et al , Manual, lated , 1923, 168 ) From Latin castigatus, subdued

Rods 04 by 1.2 microns You-mo-

Gram-negative Gelatin stab. Moderate surface

growth. No liquefaction. Agar colonies, Circular, slightly con-

vex, brittle, gravish-white, granular, entire.

Agar slant, Abundant, glistening, gravish-white growth.

Ammonia cellulose agar Enzymatic zone may attain a diameter of 2.5 mm in 30 days

Peptone cellulose agar Enzymatic gone may reach a diameter of 2 mm in 30 days

Broth Slightly turbed.

Filter paper broth Paper completely disintegrated and reduced to a pulp-like mass in 15 days

Litmus milk: Acid, not digested. Indole not formed.

Nitrites not produced from pitrates. Ammonia not produced,

Acid from glucose, maltose, lactose,

sucrose, starch and glycerol Actobic.

Ontimum temperature 20°C. Source: Soil from California Habitat, Soil.

27. Bacterium bibulum (McReth and Scales) Holland. (Bacillus bibulus Mc-Beth and Scales, Bur of Plant Industry, U S Dept of Agr , Bul, No 266, 1913, 35. Holland, Jour. Bact . 5, 1920, 217 and 221; Cellulomonas bibula Bergey et al., Manual, 1st ed , 1923, 158.) From Latin bibulus, thirsty

Rods 04 by 13 microns. Mottle. Gram-negative.

Gelatin stab. Crateriform honefaction. Cellulose agar colonies. Circular, convex, smooth, soft, grayish to faintly vellouish-white, finely granular, En-

zymatic zone 0 3 mm in some cases. Agar slant, Luxumant, elistening, smooth, moist, raised growth.

Broth Shehtly turbed.

Litmus milk. Faintly acid. Potato Smooth, glistening, canary vellow growth.

Indole is formed Natrites not produced from natrates.

Ammonia is produced Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol,

Aerobic, facultative

Optimum temperature 20°C.

Source From sever slimes and cultisated soils.

Habitat Soil.

Appendix I: The genus Cellulorionas as originally proposed was based on a single physiological property and included such diverse types of bacteria as (1) pelar fingellate species, now placed in Pseudomonas, (2) Gram variable, non motile rule non placed in Coryntheterium, and (3) perituehous, non spore forming, Gram negative rods. Unfortunately the name is unsuitable for the third of these groups as that it has not been inserted in the outline used in this edition of the Maxi'st scriptions of species previously placed in this genus are given below.

## Genus A. Cellulomonas Bergey et al. (Manual, 1st ed., 1923, 154.)

Small rods, with rounded ends, non-spore-forming, motile with peritrichous flagella, occurring in soil and having the property of digesting cellulose. Growth on ordinary culture media often not vigorous. Gram-negative.

The type species is Cellulomonas biazotea (Kellerman) Bergey et al.

## Key to the species of genus Cellulomonas.

- I. Motile with peritrichous flagella.
  - A. Gelatin liquefied. Chromogenic.
    - I. Milk acid.
      - a. Ammonia not produced; indole not formed.
        - 1. Cellulomonas biazotea.
      - 2. Milk acid; digested.
        - a. Ammonia produced; indole not formed.
          - 2. Cellulomonas aurogenes.
        - aa. Ammonia produced; indole formed.
          - 3. Cellulomonas galba.
      - 3. Milk alkaline.
        - a. Ammonia produced; indole not formed.
        - 4. Cellulomonas folia.
      - 4. Litmus milk unchanged.
        - a. Ammonia produced; indole not formed.
  - B. Gelatin liquefied. Non-chromogenic.
    - 1. Milk acid.
      - a. Ammonia not produced; indole not formed.
        - 6. Cellulomonas cellasea.
        - as. Ammonia produced; indole not formed.
      - 7. Cellulomonas iugis.
      - 8. Cellulomonas concitata.
      - 2 Milk acid; digested.
        - a Ammonia produced; indole not formed.
          - 9. Cellulomonas caesia.
  - C Gelatin not liquefied. Chromogenic.
    - 1 Milk acid
      - a. Ammonia produced; indole formed.
        - 10. Cellulomonas gilva.
    - 2. Milk alkaline
      - a. Ammonia not produced; indole not formed.
        - 11. Cellulomonas ferruginea.
  - D. Gelatin not liquefied. Non-chromogenic.
    - 1 Milk acid; not digested
      - a. Ammonia not produced; indole not formed.
        - Cellulomonas albida.
           Cellulomonas alma
      - aa. Ammonia not produced; indole formed.
      - aa. Ammonia not produced; indoic formed.

        14. Cellulomonas desidiosa.
      - ass. Ammonia produced; indole not formed.

15. Cellulomonas pusilla.

II. Motility not recorded

A. Gelstin liquefied Chromogenic.

1 Milk acid

a. Ammonia not produced. Acid from clucose.

17. Cellulomonas flaricena

as. Ammonia produced No acid from carbohydrates.

18. Cellulomonas rossica.

1 Cellulomons biazotea (Kellerman et al.) Bergey et al. (Bacilius biazoteus Kellerman, Melleth, Scales and Smith, Cent. f. Bakt., II Abt., 39, 1913, 506; Bergey et al., Manual, 1st ed., 1923, 153; Proteus cellulomona var. Proteus biazoteus Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 72)

This is the type species of the genus

Rods. 0 5 by 0 8 micron Motile with

Gram-negative. Gelatin stab. Liquefaction

Gelatin stab, Liquefaction
Agar slant, Luxuriant yellow growth
Cellulose agar: Enzymatic zone 0.25
mm or less in width

Peptone cellulose agar. No enzymatic

zone. Broth Turbid

Litmus milk Acid No curdling or

Potato Grous well.

Indole not formed.
Nitrites produced from nitrates

Ammonia not produced

Acid from glucose, multose, lactose, sucrose, and glycerol. No acid from mannifol.

Acrobic, facultative

Optimum temperature 20°C Source Soil from Utah

Habitat Soil

2. Cellulomonas aurogenes (Kellerman et al.) Bergey et al. (Bacillus aurogenes Kellerman, McBeth, Seales and Smith, Cent. f. Bakt., H. Abt., 22, 1913, 545, Bergey et al., Manual, 1st ed., 1921, 157) From Latin and Greek, gold producing

Rods, 01 by 1.4 microns Motile with one to three peritrichous flagella Gram-negative

Gelatin stab: Liquefaction

Agar slaut: Luxuriant yellow growth. Cellulose agar: Enzymatic zone 0 5 to 1 5 mm wide.

Broth: Turbid.

Litmus milk. Acid, digested

Indole not formed.

Nitrates produced from nitrates, Ammonia produced

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol

Aerobie, facultative.

Optimum temperature 20°C.
Source From soil from Louisiana and

Habitat Soil

Maine

3 Cellulomonas galba (Kellerman et al ) Bergey et al (Bacsilus galbus Kellerman, McBeth, Scales and Smith.

Cent f Bakt, H Abt, 59, 1913, 599; Bergey et al., Manual, lated, 1923, 157.) From Latin galbus, 3 ellow

Rods 04 by 10 micron Motile with one to three peritrichous flagells. Gram negative

Geletin etab Liquefection.

Ager slant Luxuriant yellow growth. Cellul-seagar Enzymatic cone 0.5 mm in width

Broth Turbel

Litrus ralk And, digested Petato No growth

Indicate is formed.

Nitrites not produced from nitrates.
Ammonia produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol.

Aerobic, facultative.

Optimum temperature 20°C. Source: Soil from Louisiana.

Habitat : Soil.

4. Cellulomonas folia Sanborn. (Jour. Bact., 12, 1926, 1 and 343.) From Latin folium, leaf.

Description from Sanborn (Jour. Bact., 18, 1929, 170) and also from his unpublished notes.

Rods. 0.8 to 1.0 by 1.0 to 1.5 microns, occurring singly and in short chains. Motile with four to six peritrichous flaxells. Gram-negative.

Gelatin stab: Slow crateriform liquefaction, becoming stratiform.

Agar slant: Growth moderate, dirtywhite, echinulate, raised, glistening, opaque, butyrous.

Broth: Turbid with yellowish sedi-

Litmus milk: Alkaline.

Potato: Thick, moist, yellowish-brown

Indole not formed.

Nitrates produced from nitrates.

Acid and gas slowly produced from glucose, sucrose, glycerol and mannitol after prolonged incubation. No acid or cas from lactose.

Starch hydrolyzed.

Staren nyarolyzea. Ammonia produced.

No H<sub>2</sub>S formed.

Aerobic, facultative.

Optimum temperature 25° to 30°C Resembles Cellulomonas rossica.

Source: From decomposing leaves. Habitat. Occurring in soil and active in decomposing leaves in composts, hav-

ing the property of digesting cellulose.

5. Cellulon onas flava Sack. (Cent. f. Bakt., II Abt., 62, 1924, 79) From

Latin flarus, yellow.

Rods: 02 by 1.5 microns. Motile.

Gram-negative.

Gelatin colonies: Circular, citron yellow.

Gelatin stab: Very slow liquefaction, Agar colonies: Large, circular, citron vellow.

Agar slant: Abundant, citron yellow streak.

Broth: Turbid with pellicle and sediment.

Litmus milk: Unchanged.

Potato: Light brown streak. Indole not formed.

Nitrites and ammonia produced from

nitrates.

Hydrogen sulfide produced.

Cellulose hydrolyzed.

Aerobic, facultative. Optimum temperature 20°C.

Habitat: Soil.

6. Cellulomonas cellasea (Kellermao et al.) Bergey et al. (Bacillus cellaseus Kellerman, McBeth, Scales and Smith, Cent. 1. Bakt., II Abt., 59, 1913, 508; Bergey et al., Manual, 1st ed., 1923, 183.)

Rods: 0.5 by 1.2 microns. Motile with one to three peritrichous flagella.

Gram-negative.

Gelatin stab: Liquefaction.

Agar slant: Limited grayish growth. Cellulose agar: Ensymatic zone 0 5 mm or less.

Broth: Clear.

Litmus milk: Acid.

Potato: No growth.

Indole not formed.

Nitrites not produced from nitrates.

Ammonia not produced.

Acid from glucose, maltose, lactose,

sucrose, starch, glycerol and mannitol.

Aerobic, facultative.

Optimum temperature 20°C.

Source: Soil from Utah,

Habitat Soil.

7. Cellulomonas iugis (McBeth) Bergey et al. (Bacillus iugis McBeth, Soil Science, I, 1916, 456; Bergey et al. Manual, 1sted, 1923, 158) From Latin, joined together.

Rods, 04 by 1.4 microns. Motile with

one to three peritrichous flacella Gram-negative

Gelatin stab: Naniform liquefaction. Agar colonies: Circular, convex, soft, gravish-white granular entire

Agar slant: Scant, gravish-white. filiform grouth

Ammonia celluloso agar. After 20 days. all colonies show an enzymatic zone of I mm or more

Pentone cellulose agar: Enzymatic zone continues to increase up to 30 days at which time it may reach 5 mm in width.

Broth, Turbid.

Filter paper broth After 15 days the paper shows many ragged holes but disintegrates readily

Litmus milk Acid, not digested

Potato: Abundant, glistening, grayish-white growth

Indole not formed

Nitrites produced from nitrates Ammonia produced.

Acid from glucose, maltose, lactore, sucrose, starch, glycerol and mannitol Acrobic, facultative,

Optimum temperature 20°C Source Soil from California Habitat Soil

8 Cellulomonas concitata (McBeth) Bergey et al (Bacillus concitatus Me-Beth, Soil Science, 1, 1916, 448, Bergey et al . Manual, 1st ed . 1923, 159 ) From Latin concilatus, rapid

Rods 0.5 by 1.2 microns Motile with one to four perituebous fingella Gram-necative.

Gelatin stab. Napiform liquefaction Agar colonies: Irregularly circular, decidedly convex, soft, becoming viscid, grayish-white, sometimes slightly fluoerecent, granular, entire

Agar elant: Abundant, flat, most, faint vellouish-white growth

Ammonia cellulose agar. Surface colonies show an enzymstic zone of 10 to 15 mm Deep colonies no sone but colony somewhat clearer than surrounding medium.

Pentone cellulose agar: Enzymatic zone, surface colonies, 2 to 2.5 mm; bottom colonies 1 mm or less Broth . Turbid

Filter paper broth: In 15 days, the namer is a disintegrated fibrous mose which retains its pure white color

Latmus milk: Acid not discosted

Potato: No growth

Indole is formed

Natrites not produced from nitrates. Ammonia not produced Acid from fructose, maltose, lactose

sucrose, starch and giveerol.

Aerobic, facultative.

Ontiroum temperature 20°C Source: Soil from California

Habitat - Soil

9. Cellulomonas caesia (Kellerman et al ) Bergey et al. (Bacillus caesius Kellerman, McBeth, Scales and Smith Cent f. Bakt . II Abt., 59, 1913, 507; Cellulomonas casera (sic) Bergey et al., Manual, 1st ed., 1923, 159; Cellulomonas cases (sic) Bergey et al , Manual, 4th ed., 1934, 199.) I'rom Latin coccius, bluish. grav.

Rods 04 by 1.5 microns. Motile with one or two peritrichous fisgella. Gramperatuse

Gelatin stab. Lanuefaction.

Beef agar streak, Moderate, flat, thin growth, slightly bluish fluorescence.

Cellulose agar Enzymatic zone, 0.5 to 10 mm in 15 days

Broth Turbid Slight rediment in 5 days.

Litmus milk Acid, digested

Potato No growth Indole not formed

Nitrates produced from nitrates

Ammonia produced Acid from glucose, maltose, lactore,

sucrose, starch, glycerol and mannitol. Aerolae, facultative

Optimum temperature 20°C. Source: Soil from Louisiana, Wiscon, sin and New Hampshire.

Habitat - Soil.

10. Cellulomonas gilva (McBeth) Bergey et al. (Bacillus gilvus McBeth, Soil Science, 1, 1916, 453; Bergey et al., Manual, Ist ed., 1923, 160.) From Latin gilvus, pale vellow.

Rods: 0.5 by 1.5 microns, Motile with one to five peritrichous flagella.

Gram-negative.

Gelatin stab: Moderate, yellowishwhite surface growth. No liquefaction. Agar colonies: Circular, convex, bu-

Agar colonies: Circular, convex, butyrous, canary-yellow, sometimes with brownish rings, granular, entire.

Agar slant: Filiform, yellowish-white growth.

Ammonia cellulose agar: Enzymic zone not more than 1 mm. Entire colony semitransparent.

Peptone cellulose agar: Enzymatic zone, 3 to 4 mm in 25 days.

Broth: Slightly turbid.

Filter paper broth: In 15 days, the paper is reduced to a thin, white filmy mass which disintegrates readily.

Litmus milk: Acid, not digested.
Potato: Abundant, canary-yellow
growth.

Indole is formed

Habitat, Soil

Nitrites produced from nitrates.

Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol

on mainteoi Aerobic, facultative Optimum temperature 20°C. Source Soil from California

11. Cellulomonas ferruginea (Rullmann) Bergey et al. (Bacillus ferrugineus Rullmann, Cent. f. Bakt., I At., Orig., 24, 1898, 465; van Iterson, Cent. f. Bakt., II Abt., II, 1904, 601; not Bacillus ferrugineus Rullmann, Cent. f. Bakt., I Abt., 24, 1898, 467, Bergey et al., Manual, 1st ed., 1923, 150.) From Latin, rust-colored.

Rods 0 5 to 0 8 by 1.5 to 2.0 microns, occurring singly. Motile, possessing peritrichous flagella. Gram-negative.

Gelatin colonies: Brown, the pigment diffusing into the medium.

Gelatin stab: No liquefaction.
Agar slant: Rusty-brown streak.
Broth; Turbid.

Litmus milk; Dark-yellow ring; alka-

Potato: Rusty-brown streak. Indole not formed.

Nitrites not produced from nitrates. Ammonia not produced.

Aerobic, facultative. Optimum temperature 25°C.

Habitat: Water.

12. Cellulomonas albida (McBeth) Bergey et al. (Bacillus albidus McBeth, Soil Science, 1, 1916, 445; Bergey et al., Manual, 1st ed., 1923, 160.) From Latin albidus, white.

Rods: 0.4 by 1.0 micron. Motile with one to three peritrichous flagella. Gram-negative.

Gelatin stab: Scant growth. No lique-

Agar colonies: Circular, convex, soft, grayish-white, granular, entire.

Agar slant: Scant, white streak.

Ammonia cellulose agar: After 30 days
the colonics show an enzymatic zone of
1 to 2 mm.

Broth: Clear.

Filter paper broth: In 15 days, the paper is reduced to a thin, filmy, grayish-white mass which readily breaks up.

Litmus milk: Slightly acid, not di-

Potato: No growth

Indole not formed.

Nitrites not produced from nitrates. Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch, glycerol and mannitol.

Aerobic, facultative.

Optimum temperature 20°C.

Source: Soil from California. Habitat: Soil.

Cellulomonas alma (McBeth) Bergey et al. (Bacillus almus McBeth, Soil Science, 1, 1916, 446; Bergey et al.,

Manual, 1st ed., 1923, 161.) From Latin almus, nourishine.

Rods 0.5 by 1.2 microns Motile with one to five peritrichous flarella. Gramnomitiva

Gelatin stab: Scant growth. No houcfantion

Agor colonies: Circular convey soft becoming brittle gravish-white granular, entire.

Ammonia cellulose agar. Passmatic zone 3 to 4 mm in 25 days

Pentone cellulose agar. Enzymatic zone 2.5 to 3.5 mm in 30 days

Acar slant: Scant, gravish-white growth, becoming vellowish-white

Broth · Shehtly turbid. Filter paper broth Paper reduced to a loces felt-like white mass in 15 days Litmus milk: Slightly acid, not di-

gested. Potata: No growth

Indole not formed

Nitrites not produced from nitrates Ammonia not produced.

Acid from glucose, maltose, lactose, sucrose, starch and glacerol. No acid from mannitol

Aerobic, facultative.

Ontimum temperature 20°C. Source, Soil from California Habitat: Soil.

14 Cellulomonas desidiosa (McBeth) Breed (Bacillus desiduosus (sic) Mc-Beth. Soil Science. 1, 1916, 450; Cellulomonas deciduosa (sic) Bergey et al , Manual, 1st ed., 1923, 162, Breed, in Manual, 5th ed. 1939, 495) From Latin desidiosus, inactive, Rods 04 by 10 micron. Motile with

one to three peritrichous flagella Gram-negative

Gelatin stab. Moderate growth. No liquefaction

Agar colonies; Circular, slightly convey, soft, becoming somewhat viscid, gravish-white, granular, entire.

Agar slant. Scant, flat, grayish-white growth.

Ammonia cellulose agar: Enzymatic zone 3 to 3 5 mm in 25 days.

Pentone cellulose agar: Enveration zone I to 2 mm around surface colonies. Bottom colonies frequently show no ensymplic some until after 20 days Broth: Slightly turbid.

Filter names broth. Paper is divided into gray white mass which readily dis-

integrates Lumus milk. Acid not directed

Potato. No growth.

Indale is formed

Natrites produced from pitrates Ammonia not produced.

Acid from clucose, lactose, maltose and starch. No acid from mannitol. sucrose or elycerol.

Aerobic, facultative,

Ontimum temperature 20°C Source Soil from California Habitet Soil

15. Cellulomonas pusilla (Kellerman et al ) Bergey et al. (Bacillus pusilus (sic) Kellerman, McBeth, Scales and Smith, Cent. f Bakt., II Abt , 39, 1913. 513, Cellulomonas pusila (sie) Bergey et al . Manual, 1st ed., 1923, 161 ) From Latin pusilla, very small.

Rods. 06 by 1.1 microns, Motile with one to three peritrichous flurella. Gram-negative.

Gelatin stab. No liquefaction

Agar slant: Scant, gravish-white growth.

Cellulose agar: Enzymatic zone 1 mm or less in width. Broth Turbed.

Litmus milk: Acid

Potato. No growth. Indole not formed.

Nitrites produced from nitrates.

Ammonia is produced Acid from glucose, maltose, lactose, sucrose, starch and glyccrol. No acid

from mannitol. Aerobic, facultative.

Optimum temperature 20°C

Source: Soil from District of Columbia and South Carolina.

Habitat: Soil.

16. Cellulomonas gelida (Kellerman et al.) Bergey et al. (Bacillus gelidus Kellerman, McBeth, Seales and Smith, Cent. f. Bakt., 11 Abt., 39, 1913, 510; Bergey et al., Manual, 1st ed., 1923, 162.) From Latin gelidus, stift.

Rods; 0.4 by 1.2 microns. Motile with one to three peritrichous flagella.

Gram-negative.

Gelatin stab: No liquefaction.

Agar slant: Luxuriant, grayish-white

Cellulose agar: Enzymatic zone 1,5

mm in width, Broth: Turbid.

Litmus milk. Acid, peptonized.

Potato: Grows well

Indole not formed.

Nitrites not produced from nitrates.

Ammonia is produced.

Acid from glucose, maltose, lactose, sucrose, starch and glycerol. No acid from mannitol

Aerobic, facultative.

Optimum temperature 20°C. Source. Soil from Connecticut. Habitat Soil

17. Cellulomonas flavigena (Kellerman and McBeth) Bergey et al. (Bacilius flavigena Kellerman and McBeth, Cent. f. Bakt., II Abt., 34, 1912, 488; Bergey et al., Manual, 1st ed., 1923, 165.) From Latin, yellow-producing.

Rods: 0.4 by 1.0 microsa Motility not recorded. Gram-negatillu

Gelatin stab: Liquefactiont., Agar slant Luxuriant, yellon; growth. Cellulose agar: Enzymatid 69 one 0 75

to 1.5 mm in width
Broth Turbid
Litmus milk: Acid
Potato: Grows well
Indole not formed
Nitrites produced from nitraites,
Ammonia not produced.

Acid from glucose, fructose, ara binose, zig und mice,

xylose, maltose, lactose, sucrose, devtrin, starch, inulin, salicin, glycerol and mannutol.

Aerobic, facultative.

Optimum temperature 20°C.

Source: From contaminated culture, Habitat: Soil

18. Cellulomonas rossica (Kellerman and McBeth) Bergey et al. (Bacillus rossicus Kellerman and McBeth, Cent f. Bakt., II Abt., 34, 1912, 492; Bergey et al., Manual, 1st ed., 1923, 157; Proteus cellulomonas var. Proteus rossicus Pribram, Klassifikation der Schizomyceten, Leipzig und Wen, 1933, 72.)

Rods: 0.3 by 1.2 microns. Motility not recorded. Gram-negative.

Gelatin stab; Rapid liquefaction.

Agar slant. Luvuriant, yellow growth. Cellulose agar: Enzymatic zone 0.5 to

1.0 mm in width.
Broth: Turbid.

Litmus milk: Alkaline

Potato: Grows well. Indole not formed.

Nitrites produced from nitrates.

Ammonia produced.

No acid from carbohydrate media.

Aerobic, facultative.

Optimum temperature 20°C. Source. From contaminated culture.

Habitat: Soil.

Appendix II: The following celluloscdigesting bacteria are not included above:

Achromobacter picrum Fuller and Norman. (Jour. Bact., 46, 1943, 276.)

From soil.

Bacillus aurogenes var. albus Kellerman, McBeth, Scales and Smith. (Cent. f. Bakt, II Abt., 59, 1913, 596.) From soil from New York State. Differs from Cellulomonas aurogenes in that it shows no chromogenesis.

Bacillus rossicus var. castaneus Kellerman et al. (loc. cit., 508; Proteus cellu-

ip-

ojle

from Maine, Connecticut and New York. Peritrichous. No liquefaction of gelatin. Chestnut rolor on notato.

Bacillus subalbus Kellerman et al (loc. cit, 512) From soils from Georgia, Kentucky and New York

Appendix III: The following genus has been proposed for Gram-negative rods that utilize bacterial polysacchandes as a sole source of carbon

notato

## Genus A Saccharobacterium Sickles and Shaw

(Jour. Bact , 28, 1931, 430 )

Pleomorphic, non-mottle, non-spore-forming rods Gram-negative. Grow in mineral solutions containing bacterial polysaccharides as the sole source of carbon Found in samp and other uncultivated soils Placed by the authors in the Family Mycobacteriaceae because of resemblances between these bacteria and those placed in Cylophaga, Cellfalectual and Cellibrion. As the latter genera are no longer placed in this family, Saccharobacterium is placed temporarily in this appendix to the genus Bacterium near bacteria that decompose cellulose and agar

The type species is Saccharobacterium ovale Sickles and Shaw

 Saccharobacterium ovale Sickles and Shaw (Jour. Bact, 28, 1934, 422)
 From Latin ovum, egg, ellipse

Extremely pleomorphic Young cells ellipsoidal, 1 8 by 2 0 microns, usually in peirs, contain granules which stain deeply with basic dyes Older cultures contain cells which may be from 12 to 15 microns long Non-motile. Gramnegative.

No growth on ordinary media such as beef-extract agar, blood agar, beef-extract agar slants, nutrient gelatin, potato slants, litmus milk, beef-infusion broth and beef-extract persone broth

Medium A plus pneumococcus II carbohydrate and 08 per cent agar. Very small, round, pink colonies, pinpoint in size after about 5 days. After 2 weeks 1 mm in diameter. Coherent

Litmus milk: No growth

Beef-extract peptone with 1 per cent sucrose Moderate turbidity Yellowish sediment.

Starch Hydrolyzed in Medium A containing pneumococcus II carbohydrate. Growth in lactore and sucrose broths Growth in maltose, xylose and dextrin broths in some strains. No and from inulin, mannitol, salicin and glucose broths.

Bacillus subalbus var. batatatis Kellerman et al. (loc. cit . 513). From soil from

South Carolina Differs from the above

species in that it liquefies relatin and

forms a very scant vellowish growth on

Aerobic.

Minimum temperature 20°C Optimum 34° to 35°C Maximum 37°C

Thermal death point 54°C for 10 minutes.

Minimum pH 64. Optimum pH 7.0 to 7.4. Maximum pH 7.8

Distinctive characters. The addition of 0.5 per cent sodium chloride to any favorable medium completely prevents growth of the organism (Medium A is that used by Dubos and Avery in 1931, (NH<sub>2</sub>)SO<sub>4</sub>, 1 g, K<sub>2</sub>HPO<sub>4</sub>, 2.0 g, tap water 1000 ml) Decomposes the carbohydrate of pneumococcus type II

Source: Swamps and other unculti-

Habitat. Soil

 Saccharobacterium acuminatum Sickles and Shaw. (Jour. Bact., 23, 1934, 425) From Latin acuminare, to sharpen.

Extremely pleomorphic. Young organisms are pointed, often curved rods. 0.5 by 2 microns, having a densely staining granule. The tapering pointed ends remain unstained. Older cells have rounded ends, are spherical, pearshaped or a long ellipsoid, stain weakly. Non-motile. Gram-negative.

No growth on ordinary media. See preceding species.

Medium S with pneumococcus I carbohydrate and 08 per cent agar: Very tiny, pale yellow colonies. Less than 0.5 mm in diameter.

Starch not hydrolyzed.

Growth in sucrose broth. No growth in glucose, lactose, maltose, devtrin, inulin, mannitol and salicin broths,

Aerobic.

Minimum temperature 20°C. Optimum 28° to 32°C. Maximum 34°C. Thermal death point 45°C for 10 minutes. Minimum pH 6.0. Optimum pH 6.6 to 7.2. Maximum pH 7.8.

Distinctive characters; Decomposes the carbohydrate of nneumococcus Type I. The addition to any favorable medium of 0.7 per cent sodium chloride. of 0.3 per cent beef extract or of 0.5 per cent pentone completely inhibits growth.

The composition of Medium S is as follows: MgSO7H2O, 02 g, NH4H2PO4, 1.5 g. CaCl., 0.1 g. FeCl., tr, KCl, 0.1 g. 10 cc N/1 NaOH. Distilled water 1,000 ml, pH 7.2 to 74. To this was added · the specific pneumococcus carbohydrate as a source of carbon in concentrations varying from 0.002 to 0.01 per cent.

Source: From swamps and other uncultivated soils.

Habitat, Soil.

Biernacki. nenckil 28. Bacterium . (Biernacki, Cent. f. Bakt , II Abt., 29. 1911, 166; Achromobacter nenckii Bergey et al., Manual, 3rd ed, 1930, 227.) Named for Nencki, a chemist at the Medical Institute in Warsaw.

Rods. 0.8 by 1.25 to 2.0 microns, with rounded ends, occurring singly and pairs. Capsulated. Non-motile. Gram-negative.

Gelatin colonies: Circular, converyellowish-white, granular.

Glucose and sucrose gelatin: Colonies larger and slimy.

Gelatin stab: No liquefaction.

Agar colonies: Circular, grayish white, clistening, concentric, finely granular, Agar slant: The medium is liquefied

Glucose and sucrose agar: Heavy slimy growth with gas. Faint fruity odor. Broth: Slightly turbid with gray sedi-

ment and slight odor. Litmus milk: Acid and gas formation.

Potato: Slight growth. Glycerol potato: Heavy growth with the appearance and consistency of cream.

Indole not formed. Nitrites not produced from nitrates. Acid and cas from glucose, fructose, galactose, maltose, sucrose, raffinose and

mannitol. Pruity odor in cultures Facultative anaerobe. Optimum temperature 37°C. Source: From Spanish dried grapes Habitat: Unknown

29. Bacterium polysiphoniae Lundestad. (Lundestad, Cent. f. Bakt., II Abt., 75, 1928, 331; Flavobacterium polysiphoniae Bergey et al., Manual, 3rd ed , 1930, 152.) From Greek, many tubes.

Rods: 0.5 to 0.6 by 2.0 to 4.0 microns, with rounded ends, occurring singly. Non-motile. Gram-negative.

Circular, colonies: Fish-gelatin slightly glistening, bright yellow, transparent, with denser center,

Fish-gelatin stab: Slight yellowish growth on surface. Slow saccate liquefaction. Sea-weed agar colonies: Circular, flat,

with concentric rings, diffuse margin, light yellow Agar is disintegrated.

Fish-agar slant: Yellow, flat growth, with undulate margin

Broth. Turbid with flocculent pellicle and yellowish sedement.

Indole not formed.

Nitrites not produced from nutrates No action on carbohydrates Slight hydrolysis of starch Aerobic facultative Ontimum temperature 30°C Source: See n ster of Norweggen Coast Habitat - Sea water

20 Rectarium denahachansa Lundastad (Lundostad Cent f Bakt, II Abt. 1928 329: Flavobacterium droebachense Bergey et al . Manual, 3rd ed . 1930 153. Pseudomonas droebachense Stanier. Jour Bact, 42, 1941, 544) Latinized, from Dröbak, where this organism was isolated.

Rods 05 to 06 by 20 to 26 microns. with rounded ends occurring singly Non-motile Gram negative

Fish-gelatin colonies Small circular compact, opaque, glistening, orangewellow

Fish-gelatin stab Liquefaction infundibuliform becoming stratiform

Sea-weed agar colonies Small, circular, flat, opaque, glistening, orangevellow. Agar is disintegrated

Fish-agar slant Flat, onaque, glistening, slimy, orange-vellow, entire growth Broth Slight flocculent turbidity. vellow.

Indole not formed

Nitrates not produced from nitrates Starch hydrolyzed

Slow growth on surface of glucose agar stab Nogas

Aerobic, facultative

Ontimum temperature about 37°C Minimum temperature 5° to 10°C Maximum 40°C

Stamer (loc cit) identified cultures soluted from sea water on the Pacific Coast as belonging to this species Some houghed gelatin while others did Nitrates were reduced. A vellow membraneous rellicle was formed on broth, and the temperature range is given as 5° to 35°C Optimum 25°C He renamed the organism Pseudomonas denehachensis, but reported it nonmotile

Source From sea water at Drobak on the York eman Coast

Habitat Sea nator

31 Racterium delecceriae Lundoctud (Lundested Cent f Bakt II Abt 75. 1928 332: Flavobacterium delesservae Bergev et al., Manual, 3rd ed., 1930. 153 )

Rods. 0.5 to 0.6 by 1.6 to 2.6 microns. with rounded ends occurring singly Non-motile Gram-negative

Fish-gelatin colonies Circular, transparent, glistening concentrically ranged vellow

Fish-gelatin stab Crateriform Lone. faction, with vellow sediment

Sea-weed agar colonies Circular flat. concentrically ringed, light vellow Agar is disintegrated

Fish-agar slant No growth

Broth Turbid with flocculent pellicle and sediment, light vellow Indole not reported

Nitrites not reported

No action on carbohydrates Slight hydrolysis of starch

Aerobic, facultative Ontimum temperature 23°C

Source Scawater of Norwegian Coast. Habitat Sea water

32 Bacterium boreate Lundestad (Lundestad, Cent f Bakt, II Abt. 75. 1928, 333. Flatebacterium borcale Berrey ct al., Manual, 3rd ed., 1930, 154) From Latin borealis, northern

Rods 05 to 06 by 16 to 26 microns. with rounded ends, occurring singly Non-motile Gram negative

Fish-gelatin colonics Circular. opaque, glistening, concentrically ranged, vellow

Fish gelatin stab Yellow, with crateriform honefaction

Sca-water agar colonies Circular, flat. opaque, glistening, diffuse marein, helit vellow Agar is disintegrated

Fish-agar slant: Yellow, flat, glistening, opaque, entire growth.

Broth: Finely flocculent, yellow sedi-

Indole not reported.

Nitrites not reported.

No action on carbohydrates. Slight hydrolysis of starch.

Acrobic, facultative.

Optimum temperature 23°C.

Source: Sea water of Norwegian Coast. Habitat: Sea water.

33. Bacterium ceramicola Lundestad. (Lundestad, Cent. f. Bakt., 11 Abt., 75, 1928, 332; Flavebacterium ceramicola Bergey et al., Manual, 3rd ed., 1939, 151.) From Greek, living in earthenware.

Rods 0.5 to 0 6 by 1.4 to 2.4 microns, with rounded ends, occurring singly and lying side-by-side. Non-motile. Gramnegative.

Fish-gelatin colonies: Circular, glis-

tening, transparent, yellow.
Fish-gelatin stab: Slight, yellow surface growth. Liquefaction crateriform.
See water again colonies. Circular, flat

Sea-water agar colonies: Circular, flat, transparent, glistening, diffuse margin, light yellow. Agar is disintegrated.

Fish-agar slant: Moderate, yellow, flat, entire, glistening, opaque growth. Broth: Light yellow pellicle and sediment.

Indole not reported.

Nitrites not reported

No action on carbohydrates. Slight hydrolysis of starch

Acrobic, facultative.

Optimum temperature 23°C

Source: Sca water of Norwegian Coast.

Habitat: Sea water

34. Bacterium rhodomelae Lundestad. (Lundestad, Cent f. Bakt., II Abt., 75, 1928, 331; Flanbacterium rhodomelae Bergey et al., Manual, 3rd ed., 1930, 146.)

Rods: 0.5 to 0.8 by 1.2 to 2.0 microns, with rounded ends, occurring singly, in

pairs, and at times in short chains. Motile. Gram-negative.

Fish-gelatin colonies: Circular, slightly glistening, opaque, white.

Fish-gelatin stab: Rapid infundibuliform liquefaction.

Sca-weed agar colonies: Circular, flat, thin, transparent, glistening, entire.

Agar is dissolved.
Glucose agar slant: Moderate growth, white, becoming orange-yellow, flat, un-

dulate margin, opaque, glistening.

Broth: Turbid, with pellicle and gray-

ish-yellow, slimy sediment.

Indole not formed.

Nitrites not produced from nitrates. No action on carbohydrates.

Very slight hydrolysis of starch. Aerobic, facultative.

Optimum temperature 20° to 25°C. Source: Sea water of Norwegian Coast. Habitat: Sea water.

35. Bacterium alginovorum Waksman, Carey and Allen. (Jour. Bact., 28, 1934, 215.) From M. L., alginic and Latin 2070, devour.

Rods: 0.75 to 1.2 by 1.5 to 2.0 microns, with rounded to almost elliptical ends, especially when single, occurring frequently in pairs and even in chains. Actively motile. Capsule-forming. Gram-nexative.

Alginic acid plate: Colony large, white in appearance with coarse granular ceater, entire margin. Clears up turbidity caused by the alginic acid on plate No odor.

Alginic acid liquid medium: Heavy pellicle formation. Active production of an enzyme, alginase, which brings about the disappearance of alginic precipitate in sea water medium.

Salt water medium: A slimy pellicle of a highly tenacious nature is produced, the whole medium later turning to a soft jelly.

Sea water gelatin: Active and rapid liquefaction in two to six days, at 18°C;

highly turbid throughout the liquefied zone.

zone.
Agar liquefaction: Extensive softening

of agar, no free liquid.

Sea water glucose broth. Abundant
uniform turbidity, with surface pellicle;
some strains give heavier turbidity and

others heavier pellicle

Litmus milk containing 3.5 per cent
salt: No apparent growth

Potato moistened with sea water Moist, spreading growth, ivory-colored, heavy sediment in free liquid at the bottom

Starch plate Abundant, cream-colored, slimy growth; extensive diastase production

Aerobic, microaerophilic

Optimum temperature 20°C

Source: From sea water, sea bottom sediments and from the surface of algal growth in the sea. Habitat. Very common in the sea

36 Bacterium fucicola Waksman, Carey and Allen (Jour. Bact, 28, 1934, 213) From Latin fucus, seawced and cola, dweller

Short rods: 06 to 10 by 10 to 15

microns, with ends rounded to almost coccoid; slightly curved Actively motile, with twirling motion Gram-negative.

Alginic acid plate. Colonies finely granular, entire; at first whitish, turning brown in three to five days, and later almost black, producing a deep brown soluble pigment

Alginic acid liquid medium Limited growth on surface in the form of a pellicle Frequently produces no growth at all.

Sea water gelatin Active liquefaction; no growth in stab, thin, fluorescent growth throughout liquefied zone

Agar liquefaction. Positive, although limited; only softening of agar.

Sea water glucose broth Faint turbidity; no pellicle, no sediment Litmus milk containing salt. No ap-

parent growth.

Potato moistened with sea water No

growth. Starch plate No growth.

Aerobic

Optimum temperature 20°C.

Source. From sea water near the surface of the sand bottom

Habitat; Rare in sea water

Appendix I: Additional agar-digesting bacteria placed in genera other than Bacterium

I. Achromobacter

A Motile with peritrichous flagella

1 Nitrites produced from nitrates

1. Achromobacter pastinatar.

II. Agarbacterium.

A. Non-motile

Nitrites produced from nitrates.

2 Agarbactersum bufo

B Motile, but position of flagella not recorded

Nitrites produced from nitrates

3. Agarbacterium reducans

4 Agarbacterium viscosum

2 Nitrites not produced from nitrates

5. Agarbactersum mesentericus.

6. Agarbacterium aurantiacum. 7. Agarbacterium cyanoides

3. Seven additional species that are numbered but not named

## III. Flavobacterium.

- A. Non-motile.
  - 1. Nitrites produced from nitrates.
- B. Peritrichous flagella.
- 8. Flavobacterium uliginosum.
  - - 1. Nitrites produced from nitrates.
      - 9. Flavobacterium amocontactum.

1. Achromobacter pastinator Goresline. (Jour. Bact., 26, 1933, 412.) From Latin pastinator, one who digs a trench.

Short rods: 0.4 by 1.5 microns, occurring singly and in pairs. Motile with tuo to five peritrichous flagella. Gram-· negative.

Plain gelatin stab: No growth. Nutrient gelatin stab: Surface growth

very scanty. No liquefaction. Nutrient agar colonies: At first tiny.

almost colorless, becoming yellowish and ring-like. Agar liquefied rapidly.

Nutrient agar slant. Growth good, flat. not thick. Agar liquefied along streak often to the depth of a quarter of an inch. Pocket formed at bottom of slant filled with a rather viscous, vellowish fluid

Nutrient broth, Slight turbidity after 5 days Subsurface but no surface growth. No sediment.

Litmus milk Slightly acid after 20 days. No curd Only a trace of reduction at bottom of tube

Potato: No growth

Indole not formed

Nitrites produced from intrates. No II.S produced

Acid from arabinose, glucose, galactose, lactose, fructose, maltose, mannose, melezitose, pectin, raffinose, rhamnose, salicin, sucrose, starch and dextrin. No growth in dulcitol, crythritol, mannitol, sorbitol, glycerol, vylose and inulin. Starch is hydrolyzed.

Limits of growth: pH 59 to 90.

Optimum Temperature relations: 28°C. Good growth at 25°C. Moderate growth at 20° and 37°C. No growth at 10° and 42°C.

Facultative anaerobe

Distinctive characters: Digests agar

rapidly; colonies sink through to the glass of the Petri dish. Fehling's solution reduced by the liquefied agar. Considerable change in viscosity of agar due to the digestion.

Source: From a trickling filter receiving creamery wastes.

Habitat: Probably widely distributed in nature.

2. Agarbacterium bufo Angst. (Puget Sound Biol. Sta. Pub., 7, 1929, 49.) Short rads with rounded ends, 0.6 by

0.8 micron, occurring singly and in pairs. Non-motile. No capsules. Gram-negative.

Fish gelatin stab: Stratiform liquefaction, growth best at top.

Fish gelatin colonies: Circular, crateriform, granular.

Fish agar slant: Abundant, filiform, raised, glistening, opaque, yellow, membranous growth.

Fish agar colonies: Circular, concentrically ringed, sunken, entire, granular, vellow to orange.

Digests agar; cellulose not attacked.

Potato: No growth.

Plain milk unchanged, surface growth

· Does not produce H2S or indole. Nitrites produced from nitrates

Acid from mannitol. No acid from xylose, rhamnose, arabinose, glucose, sucrose or lactose.

Starch not hydrolyzed.

Aerobic.

Optimum temperature 25° to 28°C. Maximum under 36°C.

Source Isolated from Odonthalia kamlschatica.

Habitat: On marine algae.

3. Agarbacterium reducans Angst, (Puget Sound Biol. Sta. Pub., 7, 1929,

Short rods with rounded ends, 0 6 by 0.8 micron, occurring singly and in pairs Motile. No capsules Gram-negative.

Fish gelatin colonies, Circular, sunken, entire, crateriform, granular

Fish gelatin stab, Crateriform liquefaction, growth only near surface

Fish agar slant, Abundant, filiform, flat, glistening, smooth, onaque, white, butyrous growth.

Fish agar colonies: Moderate, circular, smooth, flat, entire, granular, white to buff or colorless

Digests agar, cellulose not attacked, Fish broth Turbid, no sediment, no surface growth.

Potato. No growth

Nitrites produced from nitrates

No H.S or indole formed Plain milk unchanged

Acid from sucrose, arabinose, rhamnose and mannitol No acid from xylose or lactore

Starch is hydrolyzed,

Aerobic.

Optimum temperature 25° to 28°C, thermosensitive. Source Isolated from Nercocustis

luetkeana.

Habitat On marine algae

4 Agarbacterium viscosum Angst (Puget Sound Biol Sta. Pub. 7, 1929, Short rods with rounded ends, 06 to

0 8 micron, occurring singly or in pairs Motile No capsules Gram-negative Fish gelatin colonies Circular, sunken,

entire, crateriform, granular Fish gelatin stab Stratiform liquefac

tion, growth best at surface Fish agar slant Abundant, raised,

glistening, smooth, opaque, gray, vesicular, viscid growth Fish agar colonies Circular, contoured, raised, lobate, granular, fluores-

cent green

Digests agar; cellulose not attacked

Fish broth · Flocculent pellicle, turbid. no sediment, fluorescent green.

Potato Abundant, filiform, glistening, smooth. yellowish-brown, butyrous growth

Nitrites produced from nitrates

No H.S or indole formed. Plain milk unchanged: surface growth

greenish No acid from rhamnose, sucrose, lac-

tose, mannitol, xylose or arabinose Starch is hydrolyzed. Acrobic.

Ontimum temperature 20° to 28°C: thermosensitive. Source: Isolated from Iridaea cordata.

Habitat, On marine algae.

5 Agarbacterium mesentericus Angst. (Puget Sound Biol Sta. Pub. 7, 1929,

49) Short rods with rounded ends, 0.6 by 0.8 micron, occurring singly or in pairs.

Motile No capsules Gram-negative Fish gelatin stab. Infundibuliform liquefaction, growth best at top

Gelatin colonies. Circular, sunken, irregular, crateriform, granular,

Fish agar slant Abundant, filiform, raised, glistening, finely wrinkled when old or dry, opaque, buff, membranous growth

Fish agar colonies Circular, concentrically ringed, flat, entire, granular, white to buff

Digests agar, cellulose not attacked. Fish broth Membranous pellicle, moderate clouding, no sediment,

Potato Spreading, raised, glistening, wrinkled, buff to yellowish, membranous growth.

Does not produce H.S or indole.

Nitrites not produced from nitrates Plain milk unchanged

Acid from mannitol No acid from xylose, rhamnose, arabinose, glucose or Jactose

Starch is hydrolyzed.

Aerobic.

Optimum temperature 20° to 28°C; thermosensitive.

Source: Marine algae; isolated from Nercocystis luctkeana.

Habitat: On marine algae.

 Agarbacterium aurantiacum Angst. (Puget Sound Biol. Sta. Pub., 7, 1929, 49.)

Short rods with rounded ends, 0.6 to 0 8 micron, occurring singly or in pairs. Motile. No capsules. Gram-negative,

Fish gelatin colonies: Circular, sunken, crateriform, entire.

Fish gelatin stab: Stratiform liquefaction, no growth along line of stab.

Fish agar slant: Abundant, filiform, flat, glistening, smooth, opaque, orange, butyrous growth.

Fish agar colonies: Circular, smooth, flat, crose, sunken, granular.

Digests agar; cellulose not attacked. Fish broth: Membranous pellicle, tur-

bid, no sediment.

Plain milk unchanged; surface growth

orange.

Potato: Abundant, filiform, flat, dull,

smooth, orange, butyrous growth.

Nitrites not produced from nitrates.

No H<sub>2</sub>S or indole formed.

No has or indois formed.

No acid from lactose and mannitol. No acid from xylose, rhamnose, arabinose, rlucose or sucrose.

Starch not hydrolyzed.

Aerobic.

Optimum temperature 20° to 28°C; thermosensitive

Source. Isolated from Porphyra perforata.

Habitat: On marine algae.

7. Agarbacterium cyanoides Angst. (Puget Sound Biol. Sta. Pub., 7, 1929, 49.)

Short rods with rounded ends, 0.8 by 14 microns, occurring singly or in pairs. Motile. No capsules Gram-negative Fish gelatin colonies: Circular, sunken,

entire, crateriform, granular
Fish gelatin stab Stratiform liquefac-

tion, growth only at top
Fish agar slant. Abundant, filiform,
raised, glistening, smooth, opaque, gray,
butvrous growth.

Fish agar colonies: Circular, smooth, flat, lobed, granular, greenish to yellowish.

Digests agar; cellulose not attacked. Fish broth: Flocculent pellicle, turbid, no sediment, fluorescent green.

Potato: Abundant, filiform, raised, glistening, smooth, buff, butyrous growth.

Nitrites not produced from nitrates. No H.S or indole formed.

Plain milk acidified, greenish surface

Acid from sucrose. No acid from xylose, arabinose, glucose, lactose, mannitol or rhamnose.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 20° to 25°C; thermosensitive.

Source: Isolated from Iridaea cordata. Habitat: On marine algae.

Note: Seven additional species are described with as much detail by Angat (loc. cit.) as are the six above species; but he refers to them only as Agarbaterium Nos. 5, 6, 7, 8, 9, 13, 14, and 15. All digest agar.

 Flavobacterium uliginosum ZoBeli and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 263.) From Latin uligo, ooze or moist mud.

Rods: 0.4 to 0.6 by 1.2 to 3.9 microns, some slightly curved, occurring mostly singly with some short chains. Non-motile. Gram-negative.

All differential media except the freshwater broth, litmus milk, and potato were prepared with sea water.

Gelatin colonies: I mm, orange,

sunken.

Gelatin stab: Infundibuliform lique-

Gelatin stab: Infundibuliform inquefaction. Yellow pigment. Gelatin discolored brown.

Agar colonies: Sunken, uneven, irregular, gummy colonies which liquely agar. Produces orange to yellow pigment and discolors agar brown.

Agar slant: Luxuriant, yellowish-

orange, glistening, filiform, adherent

Sca-water broth: Dense yellow pellicle, moderate turbidity, slightly viscid sedi-

Fresh-water broth: No visible growth. Litmus milk Completely decolorized,

neutral Potato. No visible growth

Indole not formed

Nitrates rapidly reduced to nitrites Produces acid but no gas from xylose, glucose, maltose, lactose, sucrose and salicin Does not ferment glycerol or mannetal

Starch not hydrolyzed.

Hydrogen sulfide not formed

Ammonia produced from peptone but

Cascin digested

Fats not hydrolyzed

Agar liquefied rapidly However, after prolonged laboratory cultivation this organism gradually loses its ability to direct near

Aerobic, obligate.

Optimum temperature 20° to 25°C Source Marine bottom deposits

 Flavobacterium amocontactum Zo-Bell and Allen. (Jour Bact, 29, 1935, 216) From Latin amo, to love and contactus, touching, contacting

Slender rods 0.4 to 0.7 by 16 to 2.3 merons, with rounded ends, occurring singly and in irregular clumps. Stan very lightly. Possess well-defined capsules Actively motile by means of peritrichous flagella. Gram-neartive

Gelatin stab: Good filiform growth with rapid saccate liquefaction

with rapid saccate liquefaction
Agar colonies: Circular, 2 0 to 4 0 mm
in diameter, yellow

Agar sint Abundant, filiform, rmooth, glistening, abundant, bright yellow growth having a butyrous consistency. Originally liquefied agar, but this property was lost following artificial cultivation.

Sea water broth: Good growth with ring at surface Strong turbidity and abundant viscid sediment. No odor. Milk: No growth,

Potato dialyzed in sea water: Slight

Indole not formed.

Nitrites produced from nitrates.

Ammonia liberated from pentone

Hydrogen sulfide produced.

No acid from glucose, lactose, sucrose, vylose or manutol.

Starch not attacked.

Optimum reaction pH 8.0.

Optimum temperature 18° to 21°C.

Facultative aerobe.

Distinctive character: Adheres firmly

to submerged glass slides; cannot be removed with running water.

Source: Many cultures isolated from

glass slides submerged in sea water. Habitat: Sea water.

Appendix II: Another species described recently is:

Bacillus exidens Wieringa (Wieringa, Jour. Microbiol. and Serol., 7, 1941, 121, Bacillus agar-exedens Wieringa, idem.) From stable manure, leaf-mold and soil. Liquefies agar.

37 Bacterium chilinophilum Hock. (Jour Marine Res , 4, 1941, 103) From M. L., chilin and Greek philos, loving. Short rods 0 35 to 0 65 by 0 95 to 1.5

microns. Motile Gram-negative.

Sea water gelatin. Liquefaction;
growth absent in stab but abundant in

liquefied zone Sea water agar plate. Colonies circu-

lar, smooth, entire, raised, white.

See water liquid medium. Moderate
growth, sometimes with formation of

ring or pellicle. Scant granular sediment.

Decomposes natural chitinous material

such as horseshoe crab shells and also purified chitin.

Four out of five strains produce ni-

Four out of five strains produce nitrites from nitrates.

Acid from glucose and usually from sucrose, glycerol and mannitol. One of five cultures produced acid from lactose. Does not digest cellulose. Does not hydrolyze starch.

Does not produce hydrogen sulfide. Aerobic.

Optimum temperature 20°C.

Source: From the shell of a decomposing horseshoe crab, Limulus polyphenus, and from the intestinal tracts of Venus mercenaria, Ovolipes occilatus, Mustelus mustelus and Spheroides maculatus.

Habitat: Common in marine sand, mud and water.

38. Bacterium chitinochroma Hock. (Jour. Marine Res., 4, 1941, 105.)

Short rods: 0.45 to 0.75 by 0.90 to 1.4 microns. Motile, Gram-negative.

Sea water gelatin: Active liquefaction; no growth in stab, but thick bright yellow growth throughout the liquefied zone.

Basic agar plate: Colonies circular, smooth, entire, raised, varying in color from lemon to deep orange.

Basic liquid medium: Abundant growth with production of pellicle. Scant granular sediment, increasing with age of culture.

Decomposes natural chitinous material such as horseshoe crab shells and also purified chitin.

Does not produce nitrites from ni-

trates.

Acid from glucose and sucrose, but not lactose, glycerol and mannitol.

Does not digest cellulose. Hydrolyzes starch.

Does not produce hydrogen sulfide. Aerobic

Optimum temperature 20°C

Source From the intestinal tract of the squid, Loligo pealers Common.

Habitat Marine sand, mud and water.

Appendix I: The first species of chitinovorous bacteria that was described and named was placed in the genus Bacillus because it was a motile rod.

 Bacillus chitinororus Benecke.
 (Bot. Zeitung, 63, 1905, 227.) From M. L. chitin, chitin; vorus, devouring. Rods: 0.75 by 2.0 microns. Sometimes in pairs and chains. Motile with peritrichous flagella. Gram-negative.

Gelatin stab: Liquefaction.

Mineral agar containing chitin: Good growth if no sugar is added to produce acid. Non-chromogenic.

Peptone mineral agar containing chitin: Good growth if reaction is neutral to slightly alkaline.

Salt in concentrations up to 11 per cent is favorable for growth. Maximum 4 per cent.

Peptone broth: Turbid with heavy, slimy, whitish to brownish pellicle.

Nitrites produced from nitrates.

Ammonia produced in peptone-chitin

Ammonia produced in peptone-chitic media.

Acid from glucose and sucrose Optimum temperature 20°C.

Source: Isolated at Kiel from media containing decomposing crab shells and from media containing purified chitin; also from soil.

Habitat: Brackish water and soil.

Notes Bacillus tumescens Zopf, Bacillus cohaerens Gottheil, Bacillus proteus vulgaris Kruse, Bacillus coli communis Sternberg, Bacillus Ruorestens liguefaciens Flugge, Bacillus megotherium De Bary, Vibrio aquatilis Gunther and Spirillum rubrum von Esmarch did not attack chitin under the conditions tested by Benecke (loc. cit).

Benton (Jour. Bact, 29, 1935, 449) describes but does not name 17 types of entimovorous bacteria isolated from water, mud and plankton of fresh water lakes, from decaying May fly nymb shells, intestinal contents of fish, frogs, bats, snipe, and crayfish. Also shore soil, composts, etc. Twelve types are reported to be monotrichous, two are peritrichous and three, position of flagella not stated. Of two Gram-positive types, one may have been a sportformer and the other a Corynebacterium. Two types digested cellulose

ZoBell and Rittenberg (Jour. Bact., 55, 1938, 275) isolated and studied but did not name 31 cultures of chitings lastic bacteria from marine sources 16 cultures studied intensively all were Gram-negative All but 4 of the 31 cultures nore metile. One culture no a coccus and two species were vibries None digested collulose

\*39 Bacterium phosphoreum (Cohn) Molisch (Merococcus phosphoreus Cohn, see letter addressed to J. Penn. Varrameling van stukken hetreffende het conceskundig staatstoezicht in Nederland, 1878, 126. Bacterium phosphorescens Fischer, Cent. f. Bakt., 3, 1888, 107. Photobacterium phosphorescens Beijerinck, Arch Neerl d Ser Exactes, 23, 1889, 401, Streptococcus phosphoreus Trevisan I geneti e le specie delle Batteriacee, 1889, 31, Bacillus phosphoreus Macé, Traité de Baet , Paris, 4th ed., 1901, 995, Micrococcus phosphorescens Chester, Man Determ Bact . 1901, 181, Molisch. Die Leuchtende Pflanzen, 1912, 66, Photobacter phos phareum Bouerinek, Folia Microbialogica, Delft. 4, 1916, 15, Photobacterium phasphoreum Ford, Textb of Bact . 1927, 615)

Description from Lischer (loc cit) Coccobacilli Occur frequently as zooglea Non-motile Stain lightly with ambine dies

Gelatin No honefaction

Gelatin streak Gray-white growth Broth No growth

Milk No growth

Potato No growth

Perments carbobydrates

Blue-green phosphorescence

Minimum temperature 5°C Maximum 25°. Optimum for luminescence 10°C

Aerobic, facultative

Source Isolated from luminous fish Habitat Found commonly on dead

fish, meat, etc

40 Bacterium phosphorescens Indicenus (Disenberg) Chester (Linbeimischer Leuchthaullus Fischer Cent f Bakt . 3, 1888, 107; Photobacterium fischers Benerinek, Arch Néerl d Sci Exactes 23 1880 401: Racillus fischers Trevisan. I generi e le specie delle Batteriacee, 1889, 18, Bacillus phosphorescens indicenus Disophore Bakt Diag. 3 Aufl. 1891, 124: Vibrio fischeri Lehmann and Neumann, Bakt, Diag., 1 Aufl . 2 1896 342: Chester Ann Rent Del Col Acr Exp Sta . 9, 1897, 121; Microspira fischeri Chester, Man. Determ Bact 1901 333 Spirilium phosphorescens Holland, Jour. Bact . 5, 1920. 225 Ushrio phosphorescens Holland alad . 226. Achromobacter fischers Bergey et al Manual 3rd ed 1930 220 1

Description from Fischer (loc. cit )

Short thick rods 0.4 to 0.7 by 1.3 to 2.1 microns, with rounded ends, occurring singly and in pairs. Motile. Stain with the usual aniline dyes

Johnson, Zworykin and Warren (Jour. Bact . 46, 1913, 167) made pictures with the electron microscope of a culture which they identify with this species. The organisms have a tuft of polar flacella, indicating that this species belongs in the genus Pseudomonas

Gelatin stab Liquefaction Gelatin colonies Liquefaction one week, circular, I mm in diameter,

Broth No growth. Milk No growth

Blood serum No growth

Potato No growth.

Cooked fish Abundant growth tire surface covered with a gray-white, slimy, phosphorescent mass Temperature relations Minimum 5°

to 10°C Optimum 22°C. Serolac

Source From sea water at Kiel and from herring.

<sup>·</sup> Dr. Trank H. Johnson, Dept. Bucteriology, Princeton Univ., Princeton, New Jersey, assisted in preparing the section on phosphorescent bacteria, May, 1916

Habitat: Live on dead fish and in sea water.

41. Bacterium hemophosphoreum Pfeisser and Stammer. (Pfeisser and Stammer, Ztschr. f. Morph. u. Oköl. d. Tiere, 29, 1930, 136; Brucella (7) haemophosphoreum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 67.)

Rods: 1.0 by 4.5 microns, the size varying with the medium. Seem to show bipolar staining.

Fish agar with 3 per cent sea salt: Good growth.

Litmus milk: Acid. Reduction.

Potato: Yellow growth, medium be-

Indole not formed.

Nitrites not produced from nitrates. Acid from glucose, sucrose, lactose, maltose, galactose, mannitol and fructose.

Phosphorescent.

Pathogenic for other insects.

Source. Isolated from the blood of diseased larvae of the mealworm, Tenebrio molitor.

Habitat: From diseased insect larvae-

Appendix 1: The following phosphorescent species have been described in the literature. Many are incompletely described and they have been placed in various genera without adequate study. Achromobacter argenticophosphorescens

(Katz) Bergey et al (Bacillus argenteophosphorescens I, Katz, Cent. 1. Bakt., 9, 1891, 157; Bacterium argenteo-phosphorescens Chester, Ann. Rept. Del. Col Agr Exp Sta., 9, 1897, 121; Bacillus argenteo-phosphorescens Migula, Syst. d. Bakt., 2, 1900, 869; Photobacillus I, Miquel and Cambier, Traité de Bect., Paris, 1902, 881; Bergey et al., Manual, 3rd ed., 1930, 221) From sea water in Elizabeth Bay, Sydney, Australia. Silver-white luminescence Probably a variety of Photobacterium fischeri Beijerinck, according to Katz.

Achromobacter cyaneophosphorescens

(Katz) Bergey et al. (Bacillus cyaneo. phosphorescens Katz, Cent. f. Bakt, 9, 1891, 158; Photobacterium cyaneum Ludwig, according to Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 331; Photobacterium cyano-phosphorescens (sic) Ford, Textb. of Bact., 1927, 619; Vibrio cyaneo-phosphorescens Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 543; Bergey et al., Manual, 3rd ed. 1930, 221.) From sea water in Little Bay, near Sydney, Australia. Bluishgreen luminescence. Identical with or similar to Photobacterium indicum Beilerinck, according to Katz.

Achromobacter luminosum Bergey et al. (Bacillus argenteo-phorphorescens II, Katz, Cent. 1. Bakt., 9, 1891, 157; Bacterium argenteo-phosphorescens Migula, Syst. d. Bakt., 2, 1900, 455; Photbacillus II, Miquel and Cambier, Traité de Bact., Paris, 1902, 882; Bergey et al., Manual, 3rd ed., 1930, 226.) From fish obtained in the market. Greenish-silver luminescence.

Achromobacter phosphoreum (Migula)
Bergey et al. (Bacillus argenteo-phosphorescens liquefacions Katz, Cent. I.
Bakt., 9, 1891, 157; Bacillus phosphoreus
Migula, Syst. d. Bakt., 2, 1906, 907;
Bergey et al., Manual, 3rd ed, 1930, 222.)
From sea water along the coast near
Sydney, Anstralia. Luminescence
Bight. Probably identical with Photobacterium luminosum Beigeinck;

Achromobacter phosphoricum (Migult)
Bergoy et al. (Bacillus argenteo-phosphorescens III, Katz, Ceat. (1 Bakt., 9,
1891, 157; Bacillus phosphoricus Migult)
Syst. d. Bakt., 2, 1900, 870; Photobacillus
III, Miquel and Cambier, Traité de
Bact., Paria, 1902, 882; Bergey et al,
Manual, 3rd ed , 1930, 223.) From
cuttlefish (Sepia sp) obtained in the
fish market. Bluish-greenish-white
luminescence.

Achromobacter smaragdinophosphorescens (Katz) Bergoy et al. (Bactlus smaragdino-phorphorescens Katz, Cont. I. Bakt., 9, 1891, 159; Bacterium smaragdino phosphorescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 121, Bacterium smaragdino-phosphorescens Migula, Syst. d Bakt., 2, 1900, 435; Bacterium smargadinum (sic) Chester, Man Determ Bact. 1901, 181, Berge, et al., Manual, 3rd ed., 1930, 225) From hering in a fish market in Sydney, Australia. Green luminescence Probably identical with Photobacterium phosphorescens Berieinsk.

Bacillus fischer Dyar (Dyar, Ann N. Y. Acad. Sci. 8, 1895, 370, Bacterum fischer Chester, Man Determ Bact, 1901, 165) Dyar added to the confusion in the nomenclature of phosphorescent organisms by giving this name to four cultures received by him from the Krall collection labeled Photobacterium phosphorescens, Photobacterium ballicium, Photobacterium fischeri and Photobacterium fischeriand fische

Bacterium chironomi Issatschenko (Bulletin du Jardin Impérial botanique à St Pétersbourg, 11, 1911, 37, Photobacterium chironomi Issatschenko, ibid, 43) A phosphorescent bacterium from a genus of midres. Chironomis

Bacterium giardi (Kruse) Billet (Giard and Billet, Compt rend Soc Biol , Paris, 1889, 593, Photobacterium pathogenicum Giard, quoted from Eiskmann, see abst in Cent f. Bakt , 12, 1892, 656, Photobacterium mardi Krusc, in Plugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 333, Bacillus phosphorescens giardi Kruse, idem. Bacterium phosphorescens grardi Chester, Ann Rept Del. Col. Agr. Exp. Sta. 9, 1897, 125, Billet, Bull Sci France et Belgique, 21. 1898, 144, Bacterium phosphorescensgrards Chester, Man Determ Bact, 1901, 182 ) Pathogenic for marine crustaceans

Bacterum hippanici Issatschenko (loc. cit, 47). From fresh water fish Bacterium lucens (van Tieghem) Nuesch (Micrococcus lucens van Tieghem; Nuesch, Karsten's Deutscho Flora, 1880; quoted from Ludwig, Cent f Bakt, 2, 1887, 375) From luminous meat Considered identical with Bacterium phosphoreum

Bactersum luminosus (Beijerinck) Chester (Photobacterium luminosum Beijerinck, Arch. Néerl. d. Sci. Evactes, 23, 1839, 401; Vibro luminosus Beijerinck, Bot. Zeit, 1839, 753, according to Trevisan, I generi e le specie delle Batteriacee, 1839, 23, Bacillus luminosus DeToni and Trevisan, in Saccardo, Salben Trevisan, in Saccardo,

Syst d Bakt., 2, 1900, 1015; Photobacter luminosum Beijerinck, Folia Microbiologica, Dellt, 4, 1916, 15.) From sea water.

Batterium pelagia Dubois (Dubois, Compt rend. Acad Sc., Pans, 107, 1888, 502 and 111, 1890, 363; Bacillus pelagia DeToni and Trevisan, in Saccardo, Sylloge Fungorium, 8, 1889, 959.) Isolated from the surface of Pelagiae nocellucae

Bacterium pfluegers Ludwig (Ludnig, Zischr. f. wissensch, Mikrosk., J. 1884, 181, Micrococcus pflügers Ludwig, Hedwiga, No 3, 1884; Arthrobacterium pflügers Delbary, 1887, Photobacterium pflügers Beijerinck, Cent. f. Bakt., 8, 1890, 617, Bacterium phosphorescenpflugers Chester, Ann Rept Del Col. Agr Exp Sta., 9, 1897, 125) From fish and meat Considered identical with Bacterium hosphoreum

Bacterium pholas Dubois (Compt rend. Acad. Sci., Paris, 107, 1888, 502.) Isolated from Pholadis dactyli

Bacterium phosphorescens Hermes (Hermes, Sitsungsber naturf. Freunde, April 19, 1887, quoted from Cent. f Bakt. 2, 1887, 401; Bacillus hermes: Trevisan, f. genen e le specie delle Batteriacee, 1889, 18) From sea water. Macé (Traité de Bact, Paris, 4th ed., 1901, 991) says this may be the same as Micrococcus phosphoreus Cohn. Emerald-green luminesecence.

Bacterium phosphorescens gelidus (Eisenberg) Chester. (Phosphorescirenden Mikroorganismen, l'orster, Cent. f. Bakt., 2, 1857, 337; Bacillus phosphorescens geltdus Eisenberg, Bakt. Diag., 3 Aufl., 1891, 182; Chester, Ann. Rept. Del. Col. Agr Exp Sta., 9, 1897, 125.) From phosphorescent sea fish. Fischer (Cent. f. Bakt., 4, 1888, 89) states that this organism is the same as his Bacterium phosphorescens.

Coccobacillus acropoma Yasaki and Haneda. (Yasaki and Haneda, 1936; quoted from Harvey, Living Light, Princeton, 1940, 33.) From a fish (Acro-

poma japonicum).

Coccobacillus coclorhynchus. (Studied by Hsu, Sci-i-kai Mcd. Jour., 56, 1937, 1; queted from Harvey, Annual Rev. of Biochem., 10, 1941, 543) From a deepsea fish (Coclorhynchus sp.).

Coccobacillus ikiensis. (Quoted from Harvey, Living Light, Princeton, 1940,

263.)

Coccobacillus loligo Kishitani. (Kishitani, Proc. Imp. Acad. Tokyo, 4, 1928, 69; quoted from Harvey, Living Light, Princeton, 1940, 35) From the squid (Loligo edulis).

Micrococcus cyanophos. (Studied by Claren, Ann. d. Chemie, 535, 1938, 122, quoted from Harvey, Living Light,

Princeton, 1940, 184)

Micrococcus physiculus. (Quoted from Harvey, Living Light, 1940, 34) The cause of luminescence of a fish (Physiculus japonicus)

Microspira phosphoreum Yasaki. (Yasaki, see Sei-i-kai-zasshi, 45, 1926; quoted from Harvey, Living Light, 1940, 239.) Caused luminescence of a fresh-

water shrimp in Japan

Pholobacter hollandiae Beijerinck.
(Proc. Sect. Sci, Kon Akad. v. Wetensch., Amsterdam, 3, 1900, 352.) Simlar to Pholobacterium luminosum.

Photobacter hollandicum Beijerinek.
(Folia Microbiologica, Delft, 4, 1916, 15)
Photobacter hollandicum parvum

Photobacter hollandicum partum Beijerinck (Folia Microbiologica, Delft, 4, 1916, 15)

Photobacter splendidum Beijerinck. (Beijerinck, Proc Sect. Sci., Kon. Akad. v Wetensch., Amsterdam, 3, 1900, 352; Vibrio splendidus Lehmann and Neumann, Bakt. Diag., 7 Aufi., 2, 1927, 543; Photobacterium splendidum, quoted from Harvey, Living Light, Princeton, 1910, 204.) May be a variety of Photobacterium inducum.

Photobacter splendor maris Beijerinek. (Proc. Sect. Sci., Kon. Akad. v. Wetensch., Amsterdam, 3, 1900, 352.) May be a variety of Photobacterium

indicum.

Photobacterium Beijerinck. (Beijerinck, Arch. Néerl. d. Sci. Exactes, 23,
1889, 401; Photobacter Beijerinck, Proc.
Sect. Sci., Kon. Akad. v. Wetensch,
Amsterdam, 3, 1900, 352; Photospirillum
Miquel and Cambier, Traité de Bact.,
Paris, 1902, 888; Photomonas Orla-Jensen, Jour. Bact, 6, 1921, 271.) Photobacterium phosphorescens is the type
species of this genus See Bacterium
phosphoreum. Several species are
placed in this genus by Fischer.

Photobacterium annulare Fischer. (Fischer, Ergebnisse d Plankton-Expedition d. Humboldt-Stiftung, 4, 1894, 41; Microspira annularis Migula, Syst d Bakt., 2, 1900, 1014) From sea water.

Photobacterium balticum Beijerinck. (Einheimischer Leuchtbacillus, Fischer, Cent. f. Bakt., 3, 1888, 105; Beijerinck, Akad. v. Wetenschappen, Aldeel. Natuurk., 2de Reeks, 7, 1890, 239; see abst. in Cent. f. Bakt., 8, 1890, 617; Vibrio balticus Lehmann and Neumann, Bakt. Diag., 1 Aufl., 2, 1896, 341.) From water of the Baltic Sca. The relationship of Photobacterium balticum to Bacterium phosphorescens indigenus is not clear. The former species is based on a culture sent by Fischer to Beijerinck labeled Linheimischer Leuchtbacillus which Beijerinck considered to be different from his Photobacterium fischeri.

Photobacterum caraibicum Yischer. (Fischer, loc. cit., 1801, 41; Microspira caraibica Migula, loc. cit., 1015.) From sea water

Photobacterium coronatum Fischer. (Fischer, loc. cit , 41; Microspira coronata Migula, Ioc. cit. 1013 ) From sea nator

Photohacterium decenerane Fischer (Fischer loc cit 37: Microspira decenerans Migula, loc est 1015 Rocellus degenerans Beijerinek Folia Microliologica Delft, I. 1912, 1) From sea untor

Photobacterium delandense Tischer (Fischer, loc. cit., 37: Microsnira delgadensis Migula, loc. cit . 1014 ) From sea n ator

Photobacterium alutinosum Fischer (Tischer, loc cit, 41: Microspira glutinosa Migula, Ioc. cit. 1014 ) From sea nater.

Photobacterium birentum Eischer (loc, cit, 41). From marine fish

Photohaeterium papillare Precher (Fischer, loc cit 41: Microspira panillaris Migula, loc cit . 1016 ) From sea water.

Photobacterium senue (Quoted from Doudoroff, Jour Bact . 44, 1942, 151, who obtained a culture so labeled which had come from Prof Klusser's collection at Delft 1

Photobacterium tuberosum Pischer (l'ischer, loc. cit . 37; Microspira tuberosa Migula, loc. cit. 1014. Photobacter tuberculatum Beigerinck, Folia Miero biologica, Delft, 4, 1916, 15 ) From sea water

Pseudomonas tovamensis (Quoted from Harvey, Living Light, Princeton, 1910, 263 )

Sarcina noctiluca Heller fHeller. Arch, f. Physiol., path Chem u Mikr , N.P., 6, 1853-51, 41; see Harvey, Laying Light, Princeton, 1910, 6) From fish Possibly the same as Bacterium phos phoreum Molisch.

42 Bacterium erythrogioeum Ruhland and Grohmann, (Cent f Bakt, II Abt , 61, 1921, 256 ) From Greek crythree, red and glota, glue

Rode 0 5 by 2 0 microus Non motile

Gram prgatise,

Gelatin plate Red. droplet like colonies.

Gelatin stab. No liquefaction

Agar plate: Red. droplet-like colonies. Agar slant. Raised, non-spreading. glistening brick-red growth

Potato Abundant brick-red warty Appolite

Facultative autotroph

Oxidizes hydrogen in an inorganic medium under an atmosphere of H. O. and CO. Produces a pellicle on the moreanie liquid medium

Source Calcareous soil.

Habitat, Probably widely distributed in soil

43 Bacterium lentulum Grohmann (Cent. f. Bakt., II Abt., 61, 1921, 256.)

Rods 05by 1 to 2 microns. Motile by long thin peritrichous flacella. Gramneestive. Gelaten plate Colonies appear like

milk droplets.

Gelatin stab No houefaction. Year plate Tough, other vellow colonies about 7 mm in diameter.

Agar streak Parchment-like, folded. vellow streak about 1 cm broad.

Potato Heavy, vellow growth Sarahae

Pacultative autotroph

Oudizes hydrogen in an inorganic medium under an atmosphere of H. O. and COs. Produces a heavy folded nellicle on the morganic liquid medium. Source. Soil poor in lime

Habitat Probably widely distributed in soil

41 Recterium Jeucoeloeum Rubland (Cent f Bakt . II and Grohmann 1bt .61, 1921, 256 ) From Greek leukos, white and glota, glue

Rods 05 by 07 to 52 (?) microns Motile by means of peritrichous flagella. Gelatin stab No liquefaction.

Arms streak Wide, shimy, wet, ivory. colored growth

Potato Gray brown slime.

Acrebac

Pacultative autotroph

Oudizes hydrogen in an inorganic medium under an atmosphere of H. Or. and CO2. Produces a pellicle on the inorganic liquid medium.

Source: Calcarcous soil.

Habitat: Probably widely distributed in soil.

\*15. Bacterium stewartii Erw. Smith. (Sweet corn bacillus, Stewart, N. Y. Agr. Evp. Sta. Bul. 130, 1897, 423, Pseudomonas stewarti Smith, Proc. A. A. Sci., 47, 1898, 422; Smith, Bact. in Rel. to Plant Dis., 3, 1914, 89; Aplanobacter stewarti McCulloch, Phytopath., 8, 1918, 440; Bactilus stewarti Holland, Jour. Bact., 5, 1920, 220; Phytomas stewartii Bergey et al., Manual, 1st ed., 1923, 192.) Named for F. C. Stewart, American plant pathologist.

Description from Smith, U. S. Dept. Agric., Div Veg Phys. and Path., Bul. 28, 1901.

Rods. 0 4 to 0 7 by 0 9 to 2.0 microns. Capsules Non-motile (McCulloch, loc. cit.) Gram-negative.

Gelatin: No liquefaction

Nutrient agar colonies Small, round, yellow colonies.

Broth: Growth feeble with whitish ring and yellow precipitate.

Milk: Yellow ring but no visible action on the milk. Slightly acid.

Mitrites not produced from nitrates.

McNew (Phytopath., 28, 1938, 773) states that less virulent strains assimilate only organic nitrogen; those of intermediate virulence assimilate nitrogen from inorganic salts without reduction of nitrates to nitrites; virulent strains reduce nitrates to nitrites

Hydrogen sulfide not formed

Indole production slight or none.

Reduction of methylene blue in Dunham's solution feeble or doubtful

Acid but no gas from glucose, galactose, sucrose, mannitol and glycerol. No acid from maltose. Acid from fructose, arabinose and xylose (McNew, loc ett) Starch not hydrolyzed.

Optimum temperature 30°C, Mavimum 30°C, Minimum 8°C,

Optimum pH 6.0 to 80. Limits about pH 4.5 to 85.

S per cent salt restricts growth.

Strict aerobe. Source: From wilted sweet corn.

Habitat: Pathogenic on corn, Zea mays.. Sweet corn very susceptible and field corn slightly so.

46. Bacterium tardicrescens McCulloch. (McCulloch, Phytopath. 27, 1937, 135; Phytomonas tardicrescens Burkholder, Phytopath., 27, 1937, 617.) From Latin, slow growing.

Rods: 0.6 to 0.8 by 1.58 microns. Motile with a polar flagellum. Gram-negative.

Gelatin: No liquefaction.

Beef-extract agar colonies: Circular, mustard yellow, edges entire, 1 to 1.5 mm in diameter.

Broth: Light clouding.

Milk: Slightly alkaline. Clearing after 5 to 6 weeks.

Nitrites are produced from nitrates. Indole not produced.

No H.S produced or feebly so.

Acid but no gas from glucose, fructose, galactose, arabinose, xylose and rhamnose. Alkaline reaction from salts of citric, malic and succinic acid.

Starch is not hydrolyzed.

Not hpolytic (Starr and Burkholder, Phytopath., 32, 1942, 603).

Optimum temperature 26°C. Maximum 32°C. Minimum 5°C (McCulloch Phytopath., 28, 1938, 648).

Optimum pH 6.5 to 7.5. Growth slight at 5.8 and 8.0 (McCulloch, loc cit.).

No growth with 3 per cent salt (Mc-Culloch, loc. cil.).

Aerobic.

Distinctive character: Very sloverower.

<sup>\*</sup>The section covering species of interest to plant pathologists has been pre pared by Prof. Walter H. Burkholder, Cornell Univ , Ithaca, New York, May, 1916.

Source: Isolated by McCulloch and by Burkholder from blighted iris leaves. Habitat: Pathogenic on Iris ann

47. Bacterium albilineans Ashby. (Ashby, Trop. Agr., Trinidad, 6, 1929, 135; Phytomonas albilineans Magrou, in Hauduroy et al., Dict d Bact Path, Paris 1937, 396 1 From Latin produc-

ing white streaks.

Description taken from Martin, Carpenter and Weller. The Hawaiian

Planters' Record, 36, 1932, 184
Rods: 0 25 to 0.3 by 0 6 to 1 0 micron, occurring singly or in chains Mottle with a polar flagellum. Gram-negative

Agar colonies: After 7 to 10 days, minute transparent drops, moist, shining. Honey vellow to Naples vellow

Gelatin: No liquefaction.

Milk: Growth, but no visible change

No growth with ammonium solts, nitrates, or asparagine as a source of nitrogen.

No growth in reptone water without carbohydrates. Invertase secreted Starch is not hydrolyzed

Optimum temperature about 25°C Maximum 37°C.

Distinctive characters: Differs from Xanthomonas eascularum which produces a large gummy type of colony, and which is a very active organism brochemically The two pathogens also differ in the type of lesion they produce on sugar cane.

Source: Isolated by D. S. North (Colonial Sugar Ref. Co., Sidney, N.S Wales, Agr. Rept., 8, 1926, 1) from white stripe and leaf scald of sugar cane in Australus.

Habitat: Vascular pathogen of sugar cane, Saccharum officinarum.

Appendix I: The following species have been described from diseased plant tissues but may not, in some cases at least, have been the cause of the disease. Bacillus bette Migula. (Kramer, Oesterreich. Jandwritsch. Centralb., 1891,

Heft 2 and 3; Migula, Syst. d Bakt., 2, 1900, 779.) The cause of a disease of the sugar beet (Bela sulgars).

Bac. carpophyllacearum Dufrency (Compt rend. Soc Biol., Paris, 81, 1918, 920; probably there is an earlier reference to this species) On Dianthus, Saponaria and Luchnis

Bacillus coffeicola Steyaert. (Rev Zoo. et Bot. Afr , 22, 1932, 137.) From nadules on coffee roots

Bacillus lacerans Migula. (Bacillus a, Busse, Ztschr f. Pfianzenkr., 7, 18—, 72, Migula, Syst. d Bakt., 2, 1900, 780.) From diseased sugar beets.

Bacillus maculcola Delacrox. (Delacrox, Compt. rend. Acad. Sci. Paris, 140, 1905, 689, Bacterum maculcola Stapp, in Sorsuce, Handb d Pflancenkrankhetten, 5 Aufl. 2, 1928, 276; Aplanobacter maculcola Elitott, Manual Bact. Plant Path, 1930, 8, Phylomenas nicotionae-tabaci Magrou, in Hauduroy et al, Diet d Bact. Path, 1957, 385.) From diseased spots on leaves of tobacco.

Bac. nucleophyllus Dufrenoy (Compt. rend Soc. Biol, Paris, 81, 1918, 920, nomen nudum) On Rhododendron fertunneum

Bac. tritici Dufrenoy (Compt rend. Soc. Biol, Paris, 81, 1918, 920, nomen nudem, not Pseudomonas tritici Hutchinson, India Dept. of Agr., Bact. Ser., 1, 1917, 174) On wheat

1917, 174) On wheat

Bacillus vitis Montemartim (Rev.

Patol. Veg., 6, 1913, 175) Pathogenic
on the graps (Vitis vinifera)

Bacterum apus Brizu. (Law e Relaz, d Reg Staz di Patol Veg., Roma, Gennio-Gugno, 15, 1806 and Atti R Accad Naz. Lincei, Rend Cl Sc. Fis, Math e Nat, Ser 5, 6, 1897, 233) Motile. From rot of celery.

Bacterium betae Chester. (Bacterial parasite, Arthur and Golden, Indiana Agr. Evp. Sta., Bull 39, 1892, 61; Chester, Ann Rept. Del Col. Agr. Evp. Sta., 9,1897, 129; Bacillus enthur Migula, Syst. d. Bakt., 2, 1900, 681) Moille Prom diseased sugar beet tubers.

Raclerium briosianum Pavarino.

(Attı del. R. Accad. Naz. Lincei, Rend. Cl Sci. Fis, Math. et Nat., 20, 1911, 161.) Motile. From Issions on the vanilla vine

Bacterium castinicolum Cavara. (Rev. d. Pat. Veg., 7, 1914, 5) Motile. From chestnut capker.

Bacterium corylii Brzezinski. (Bull. Intern Acad des Sci. Cracovic, Cl. Sci. Math. e Nat, 1903, 139) Motile. From diseased filbert trees.

Bacterium dendrobii Pavarino. (Rev. di Pat. Veg., 5, 1912, 242.)

Bacterium dianthi Chester, (Parasite bacteria, Arthur and Bolley, Purdue Univ. Agr. Exp. Sta, Bull 59, 1896, 21; Chester, Ann Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 100; Bacillus dianthi Chester, Man Determ. Bact., 1901, 253; Pseudomonas dianthi E F. Smith, U. S. Dept. Agr., Div. Veg Phys and Path., Bull. 28, 1901, 153.) Motile. From lesions on carnation leaves.

Bacterium fici Cavara. (Ist Bot. del. R. Univ di Catania, Atti Acad. Gioen., 18, Mem. 14, 1905, 1, Phylomonas (?) fici Magrou, in Hauduroy et al., Dict d. Bact. Path. 1937, 354) Motile.

Causes a blight of figs

Bacterium lycopersici var. vittati Strzalkowska (Strzalkowska, Acta Soc. Bot Poloniae, Warsaw, 7, 1930, 611; Phytomonas vittati Burkholder, in Manual, 5th ed., 1939, 216) From rotting tomato.

Bacterium malı Brzezinski. (Bull. Intern. Acad. Sci Cracovie, Cl Sci. Math e Nat, 1903, 100) Motile.

From apple canker

Bacterium montemartinii Pavarino (Rev. di Pat Veg , 5, 1911, 65) Motile.

From wisterna canker

Bacterium (†) omedai Peglion (Peglion, 1899, quoted from Handuroy et al., Diet Bdet. Path, 1937, 388, Bacillus oncidi: Stevens, 1913, Phytomonas (†) oncidi: Hauduroy et al., idem.) From an orchid (Oncidium sp.).

Bacterium pini Chester (Bacillus des tumeurs du Pin d'Alep, Vuillemin, Compt. rend. Acad Sci., Paris, 107, 1885, 874 and 1184 Bacillus vuillemini Trevisan, I generi e le specie delle Batteriacce, 1889, 19; Chester, Ann. Rept. Del. Col. Agr. E-p. Sta., 9, 1897, 127; Pseudomonas pini Petri, Ann. Ist. Supt. For. Naz. Firenze, 9, 1924, 187.) From galls on pine (Pınus halepensis).

Bacterium putredinis Davaine. (Davaine, Bactéries, in Dictionnaire Encyclopédique des Sci. Médicales, 1886, Bacillus putredinis Trovisan, Add. ad Gen., p. 36; see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1025; not Bacillus putredinis Weinberg, Nativelle and Prévot, Les Microbes Anaérobies, Paris, 1937, 755) Causes a soft rot of several plants.

Bacterium pyri Brzezinski. (Buil. Internat. d. l'Acad. des Sci. de Cracovie, Cl. Sci. Math. e Nat., 1903, 130.) Motile. From pear canker.

Bacterium rubefaciens Burr. (Burr, Ann. App. Biol., 15, 1928, '570; Phylomonas rubefaciens Magrou, in Hauduroy et al, Diet. Bact. Path., 1937, 406; not Bacterium rubefaciens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 115.)

Bacterium suberfaciens Burr. (Burr, Ann. App. Biol., 15, 1928, 570; Phytomonas suberfacens Magrou, in Haudurov et al., Dict. Bact. Path., 1937, 417.) Motile. From diseased potato tubers

48. Bacterium rubefaciens (Zimmermann) Chester. (Bacillus rubefaciens Zimmermann, Die Bakterien unsere Trink- und Nutzwässer, Chemnitz, 1, 1890, 26, Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1857, 115; Erythrobacillus rubefaciens Holland, Jour. Bact., 5, 1920, 223; Serratia rubefaciens Bergy et al., Manual, 1st ed., 1923, 92; Chromobacterium rubefaciens Topley and Wilson, Prine Bact. and Immun, 1, 1931, 492.) From Latin ruber, red and facio, to make-

Rods 1.0 to 16 microns in length, occurring singly and in pairs. Actively

motile. Gram-negative Gelatin colonies. Minute, white.

Gelatin stab: Surface growth yellowish, the medium taking on a red tinge. No liquefaction.

Agar colonies: Small white with erose marein

Agar slant. White, smooth, glistening somewhat luxuriant the medium taling on a nine sed soles

Broth: Turbid with white pellicle the medium slowly assuming a reddish tinge Litmus milk. Acid with slow coamletion and reduction of the litmus

comme allerine

Potato A heavy, white, creamy layer, which later becomes vollowish-brown Indole not produced

Nitrites produced from nitrates Aerobic, facultative.

Ontimum temperature 25°C No growth at 27°C

Habitat Water

49 Bacterium ruhldum (Fisenberg) Chester, (Bacillus rubidus Eisenberg, Bakt. Ding . 3 Aufl . 1891, 88. Bacterium rubidus (sic) Chester Ann Rent Del Col. Agr. Evp. Sta . 9, 1897, 107 and 115. Serratia ruhida Levine and Soppeland. Iowa State Coll Engineering Exp Sta Bull 77, 1926, 53 ) From Latin rubidus, red

Description from Eisenberg (loc cit ) Levine and Soppeland (loc cit) found an organism in buttermilk which thes identified as Serratia rubida. Their description is more complete than that given by Eisenberg but differs from the original in several respects

Rods Medium size with rounded ends, often in long chains Motile

Gelatin colonies Circular, finely granular, entire, with reddish center Slow growth

Gelatin stab. Liquefaction Brown-

ish-red sediment. Ager colonies: Small, flat, smooth,

amorphous, entire, brownish-red growth. Agar slant: Brownish-red streak

Spreading over surface Potato: Brownish-red growth

Blood serum liquefied, red pigment Aerobie, facultative.

Does not grow well at 37°C Source: Water.

50 Bacterium latericoum (Adamete) Lehmann and Noumann (Racillus latericeus Adametz Die Bakterien der Trink, und Nutzwässer, Mitteil, der oester Versuchsanst f Braueres u Malzerei in Wien, 1888, 50; Bacillus eruthraeus Trevisan. I generi e le specie delle Batteriacce, 1889, 19. Bacterium laterseeum Lehmann and Neumann Bakt Diag . 1 Aufl . 2, 1896, 258, Serration latericea Bergey et al . Manual, 1st ed . 1923. 94 ) From Latin latericeus, brick

Rods, 05 to 07 by 10 to 13 microns Non-motile Gram-negative

Gelatin colonies, Small, white, granular, with slightly irregular margin.

Gelatin stab A thin, dry spreading cream-nink surface growth. No housefaction

Agar colonies, Dry, plistening, whitish with irregular margin

Agar slant Brick-red, smooth, plistening, butyrous

Broth Thick pellicle, fluid clear Latmus milk Allaline

Potato Brick red streak No gas from carbohydrate media

Indole not produced

Natrates produced from natrates. Aerobic, facultative

Ontimum temperature 25° to 30°C Halutat Water

51 Bacterium alginicum Waksman, Carey and Allen (Jour Bact . 28, 1934. 213 )

Rods short to almost spherical, 0 6 to 10 micron in diameter Sluggishly Capsule-forming motile negative

Algenic seid plate White, finely granulated colonies, with entire margin Does not clear up the turbidity in plate Odor formed, resembling that of old notatoes

Alemic acid liquid medium: Thin pellicle, weak alginase formation

Sea water gelatin Thin growth throughout gelatin stab, no liquifaction in 7 days at 15°C,

Agar liquefaction: None. Ser water glucose broth: Uniform but very limited turbidity; no pellicle; no sediment.

Litmus milk containing salt: No apparent growth.

Potato moistened with sea water: Moist, spreading growth, cream-colored; heavy sediment in free liquid at bottom.

Starch plate: Limited, pale blue

Aerobic.

Optimum temperature 20°C.

Source: From sea water, and from the surface of algal growth.

Habitat: Common in sea water.

52. Bacterium terrestraiginicum Waksman et al. (Waksman, Carcy and Allen, Jour. Bact., 28, 1934, 217.)

Long rods, with somewhat rounded ends, usually single, but also in pairs, and occasionally in chains of shorter rods. 1.0 to 1.5 by 1.5 to 2.5 microns. Motile. Granular. Gram-negative.

Alginic acid plate: Colonies small, whitish in appearance with a slight metallic sheen.

Alguic acid liquid medium: Medium at first clouded. Later, a pellicle is formed on the surface of the medium, which is soon broken up due to active gas formation. Reaction of medium becomes slightly alkaline.

Gelatin medium: Slow growth throughout stab, slow liquefaction at surface of medium at 18°C.

Agar liquefaction: None.

Glucose broth. Abundant turbidity, some sediment, no pellicle, slightly fluorescent.

fluorescent.

Litmus milk · Acid, milk coagulated, only limited digestion of coagulum.

Potato: Abundant, pinkish, compact, dry growth on surface of plug, the rest of plug becoming gray, with a tendency

to darkening.

Starch plate: Limited growth along streak, no diastase.

Aerobic to facultative anaerobic. Optimum temperature 30°C.

Source: From New Jersey soil.

Habitat : Soil.

53. Bacterium eygni Migula. (Septi-kāmiebacillus der Schwane, Fiorentmi, Cent. f. Bakt. 19, 1896, 935; Migula, Syst. d. Bakt. 12, 1900, 365; Bacillus eygneus Chester, Manual Determ. Bact., 1901, 221.) From Latin eygnus, swan.

Rods: Motile. Gram-negative.
This organism may have been the
fowl cholera or septicemia organism
(Pasteurella avicida Trevisan); but is
more probably closely related to the
organism which causes keel in ducklings
(Salmonella anatis Retter and Scoville).

Source: From a swan.

Habitat: The cause of an infectious disease of swans in the city park at Milan, Italy in 1895.

54. Bacterium eyprinicida Picha (Picha, Cent. f. Bakt., I Abt., Orig, 55, 1903-01, 461; Klebsiella eyprinicida Bergey et al., Manual, 2nd ed., 1925, 266.) From Greek kyprmos, carp and Latin caedo, to kill.

Rods: 08 by 1.0 micron, occurring singly and in chains, Capsulated. Non-motile, Gram-negative.

Gelatin colonies: White, glistening, convex, with slight fluorescence around the colony in three or four days.

Gelatin stab: White, convex surface growth. No liquefaction.

Agar slant: White, glistening layer, becoming slimy.

Broth: Turbid, with thick gray pellicle and slimy sediment.

and samy sediment.

Litmus milk: Slightly alkaline. No coaculation.

Potato: Light- yellowish layer, becoming dark brownish. The medium is dark violet-gray.

Indole not formed.

Nitrites not produced from nitrates. No acid from carbohydrate media. Acrobic, facultative.

Optimum temperature 10° to 20°C.

Habitat: The cause of a fatal disease in carp, showing as red spots on the ventral surface.

55. Bacterium parvulum Conn. (N. Y.

Agr. Exp. Sta. Bul. 491, 1922, 26.) From Latin, very small

Very small rods: 01 to 02 by 03 to 05 micron. Non-motile Gram-negative

Gelatin plate: Punctiform colonies

Grows poorly in liquid media

Nitrites produced from nitrates

No acid from glucose, lactose, sucrose, glycerol or ethyl alcohol in either liquid or solid media

Starch not digested.

Optimum temperature 25°C Strictly aerobic.

Distinctive character. Causes strong

volatilization of ammonia from a mix-

ture of horse feces and urine

Habitat, Soil.

 Bacterium methylicum (Loew) Migula (Bacillus methylicus Loew, Cent. f. Bakt., 18, 1892, 465; Migula, Syst d Bakt., 2, 1900, 447) From the chemical term, methyl.

Short, thick rods 10 by 20 to 25

Gelatin colonies: After 2 days, round to oval, yellowish, entire; later edges ciliate Liquefaction.

Glucose gelatin stab. Liquefaction cratenform. Whitish-yellowish sediment No liquefaction in depth

Glucose gelatin stab. In depth, little or no growth, slowly liquefied near surface.

Agar stab Surface growth spreading, grayish-white. No growth in depth. Broth No turbidity. On the surface

Broth. No turbidity. On the surface and adherent to the walls, a white ring which precipitates on shaking

Potato Growth very slow, pure white, adherent

Grows well in 05 per cent methyl alcohol, 005 per cent dicalcium phosphate, and 001 per cent magnesium sulfate, on which broth it forms a reddish nellicle

Possesses the ability to decompose formaldehyde and formic acid salts with formation of a reddish pellicle

Source, A culture contamination from

the air Habitat Probably soil

Appendix I: A few of the numerous Gram negative, motile or non-motile, nonspore-forming rods that do not belong in the groups previously listed in this genus are described here. All have been placed in the genus Bacillus by those who have described them, although none form spores

## I. Produce a pink to red chromogenesis

A. Motile.

1. Bacıllus lactorubefaciens

B Non-motile.

Gelatin liquefied

- 2. Bacıllus rubrıcus
- 3. Bacillus rufus 2. Gelatin not liquefied
  - a. Salmon pink on agar.
    4. Bacillus mycoides corallinus
  - aa. Vinous red on agar.

    5. Racillus bruntzii.
- Produces a water-soluble orange to emerald green pigment.
   A. Motile.
  - 1. Gelatin liquefied.

6. Bacıllus aurantiacus tingitanus

 Bacilius lactorubefaciens Gruber. (Gruber, Cent. f. Bakt., II Abt., 8, 1902, 457; Serratia lactorubefaciens Bergey et al., Manual, 1st ed., 1923, 92 )
 From Latin, to make milk red.

Small rods: 04 to 06 by 35 microns, occurring singly and in pairs. Motile with peritrichous flagella. Gram reaction not given.

Gelatin colonies Grayish-white, smooth, glistening, spreading.

Gelatin stab: At times arborescent; the medium tinged with red. No liquefaction.

Agar colonies: Circular, lobed, grayish, contoured

Agar slant White, spreading growth. Broth. Turbid, with grayish pellicle and slimy sediment.

Limus milk: Becomes rose red, slimy, slightly acid, without coagulation.

Potato: White, spreading growth.
No gas from carbohydrate media.

Indole not produced.

Nitrites produced from nitrates. Aerobic, facultative Optimum temperature 25°C.

Optimum temperature 25°C. Habitat Milk.

Habitat Milk

2 Bacillus rubricus Hefleran (Hefferan, Cent. f Bakt, II Abt., II, 1903, 403; Erythrobacillus rubricus Holland, Jour. Bact, 5, 1920, 220; Serratia rubrica Bergey et al., Manual, 1st ed., 1923, 313; Chromobacterium rubricum Topley and Wilson, Princ. Bact. and Immun., 1, 1931, 402)

Rods 07 to 09 by 10 to 4.0 microns, occurring singly Non-motile. Gram reaction not given

Gelatin colonies. Small, circular, yellow-orange, deepening to red.

Gelatin stab Slow liquefaction. Old cultures lose this property.

Agar colonies Circular, raised, entire Agar slant Moist, spreading, white to

pink, gradually deepening in color.

Broth Turbid, with viscid sediment

Litmus milk Alkaline
Potato Slight growth, bright pink,

turning coral red Indole not produced.

Nitrites not produced from nitrates

No acid or gas from carbohydrate media.

Aerobic, facultative.

Optimum temperature 25° to 30°C, No growth at 37°C.

Source: Isolated from Mississippi river water, also from buttermilk,

3. Bacillus rufus Hefferan. (Hefforan, Cent. f. Bakt., II Abt., 11, 1903, 313; Erythrobacillus rufus Holland, Jour. Bact., 5, 1920, 220; Serratia rufa Bergey et al., Manual, 1st ed., 1923, 95) From Latin rufus, red.

Differs from Bacillus rubricus in showing more luxuriant growth on potato and slower action in milk.

Source: From Mississippi River water.

4. Bacillus mycoides corallinus Hefferan. (Hefferan, Cent. f Bakt., H Abt., 11, 1903, 459; Serratia corallina Bergey et al. Manual, 1st cd. 1923, 93)

Bergey et al., Manual, 1st ed., 1923, 93)
Small, slender rods. 1.2 to 2.0 microns
in length, occurring singly and in pairs.

Non-motile. Gram reaction not given. Gelatin colonies: Minute, becoming

Gelatin colonies: Minute, beco pink, smooth, raised.

Gelatin stab: Slow growth. Raised, smooth, glistening, pink surface growth. Fine, feathery growth in stab No liquefaction.

Agar colonies: Minute, with filamentous margin.

tous margin.

Agar slant: Smooth, moist, salmon

pink.
Broth. Turbid, with pink flakes on surface.

Litmus milk: Alkaline, with red sur-

ace. Potato: Like agar slant.

Indole not formed.

Nitrites produced from nitrates. No gas from carbohydrate media. Aerobic, facultative.

Optimum temperature 25° to 30°C.

Source: Isolated from Mississippi river water.

5. Bacillus bruntzli Nepveux. (Nepveux, Compt rend. Soc. Biol., Paris, 72, 1020, 242; Thèse, Iac. de Pharm., Jouve et Cie, Paris, 1920, 136 pp.; Serratia bruntzii Bergey et al., Manual,

3rd ed., 1930, 125.) Named for Prof. Bruntz of Paris

Racillus roseus fluorescens Mar. chal (Tray, Lab Microbiol Fac Pharm Nancy, 1937, 90) is regarded by Lasseur (personal communication 1938) as identical with Recallus brantan Nenveux.

Rods: 0 3 to 0 5 by 1 25 to 1 5 microns. occurring singly and in pairs motile. Gram-negative The eller store volutin and alveggen as reserve meteriale

Gelatin colonies. Circular, grav. smooth, contoured, glistening, undulate margin, becoming red.

Gelatin stab. No houefaction

Agar colonies Circular, flat, smooth, contoured, radiate margin, vinous red Agar slant, Smooth, echinulate, bu-

tyrous, vinous red in color

Broth, Turbid.

Litmus milk Unchanged Indole not formed.

Nitrates produced from patrates Acid from glucose, fructose, maltose, lactose, sucrose, mannitol, dulcitol and

glycerol.

Aerobic, facultative Optimum temperature 20° to 25°C Habitat: Water

6. Bacillus gurantiacus tingitanus Remlinger and Bailly (Compt rend Soc Biol. Paris, 119, 1935, 246 )

Short rods Usually 2 to 3 microns, sometimes 5 to 6 microns long Actively

motile Gram-negative Growth occurs on all the ordinary

nutrient media. Fluorescent bright orange pigment

Gelatin: Rapid liquefaction Milk Slow coagulation

Synthetic broth, Lasseur, Dupary, Lasseur and Marion (Tray Lab Microhiol Tae Pharm Naney, Fasc 9, 1936. 34) recognize two rough types of this organism, one of which forms a smooth and the other a wrinkled pellicle. The smooth type gives a rough (pH 4 7) or a smooth (nH 6 3) pellicle according to the nli of the medium

Indole not formed

Artichoke media Laxumant growth. Emerald green pigment produced On transferring the culture to potato, the bright orange nigment reappears

Coagulated serum. No honefaction.

Acid from sucrose, lactose, chicose, mannitol and maltose

Non-pathogenic

Ontinum pH 66 No growth at pH 62 but grows at pH 78

Ontimum temperature 20°C Good growth from 15° to 37°C

Aerobic Prement Orange or capucine pigment which diffuses throughout the medium. Not affected by the presence or absence

of light Pigment production depends on the growth of the culture, not on the acidity of the medium. Insoluble in acetone amyl alcohol and casoline Partially soluble in ether and ethyl alcohol which are colored vellow Distinctive character A fluorescent

prement of an unusual shade (bright orange)

Source From water at Tanglers Habitat Presumably water.

Appendix II: The anaerobic genus Methanobacterium was proposed tentatively by Kluyver and Van Niel in 1936 with indication that they regarded Sohngen's methane bacterium as the type species of the genus Later, Barker (1936) found orgamsms that he regarded as identical with those previously isolated by Sohngen and he proposed the name Methanobacterium sohngenis for this species A second species found at the same time was named Methanobacterium omelianskis and it was identified as the species previously described but not named by Omehansky At the time, he felt that these anaerobes should be included in the family Mycobacteriaceae (1936.

<sup>\*</sup> The manuscript for this section has been reviewed by Dr. H. Albert Barker. University of California, Berkeley, California, February, 1945.

p. 422). In 1940, he discovered that the second species produced spores. In a personal communication (March 20, 1945) he suggests that further work is needed before the relationships of these organisms can be clarified.

## Genus A. Methanobacterium Kluyver and Van Niel. (Cent. f. Bakt., II Abt., 94, 1936, 399.)

Straight or slightly bent rods, sometimes united in bundles or long chains. Usually non-motile. Endospores sometimes formed. Anaerobic. Chemo-heterotrophic or chemo-autotrophic oxidizing various organic or inorganic compounds and reducing carbon diovide to methane. Gram-variable, usually negative.

The type species is Methanobacterium soehngenii Barker.

 Methanobacterium soehngenil Barker. (Methanebacterium, Sohngen, Dissortation, Delft, 1906; Barker, Arch. f. Mikrobiol., 7, 1936, 433.) Named for Prof. N. L. Söhngen who first studied this organism.

Rods: Straight to slightly bent, moderately long. Non-motile. Non-spore-forming. Gram-negative.

In liquid cultures cells are characteristically joined into long chains which often he parallel to one another so as to form bundles

Acetate and n-butyrate but not propionate are fermented with the production of methane and carbon dioxide.

Ethyl and n-butyl alcohols not fermented.

Obligate anaerobe.

Source: Enrichment cultures containing acetate or butyrate as the only organic compound Four strains were isolated from acetate enrichment cultures. The cultures were highly purified but not strictly pure.

Habitat: Canal mud, sewage. Probably occurs widely in fresh water sediments where anaerobic conditions prevail.

2. Methanobacterium omelianskil Barker. (Bacille de la décomposition méthanique de l'alcohol ethylique,
Omeliansky, Ann. Inst. Past., 30, 1916,
80; Barker, Arch f. Mikrobiol., 7, 1936,
436; also see Barker, Antonie van Leeuwenhoek, 6, 1940, 201 and Jour. Biol.
Chem., 137, 1941, 153.) Named for
P1of. W. Omeliansky who first observed
the organism.

Rods: 0.6 to 0.7 by 1.5 to 10 microns, usual length 3 to 6 microns, unbranched, straight or slightly bent. Usually nonmotile, occasionally feeble motility is observed. Spores of low heat resistance formed, spherical, terminal, swelling the rods.

Primary alcohols, including ethyl, propyl, n-butyl and n-amyl alcohols, are ovidized to the corresponding fatty acids. Secondary alcohols, including isopropyl and sec-butyl, are ovidized to the corresponding ketones. Hydrogen is oxidized.

Fatty and hydroxy acids, glucose, polyalcohols and amino acids are not attacked.

Carbon diovide is used and converted to methane Growth and alcohol oxidation are directly proportional to the carbon diovide supply at low concentrations.

Nitrate, sulfate and ovygen cannot be used as oxidizing agents.

Utilizes ethyl alcohol best of all organic compounds.

Utilizes ammonia as a nitrogen source Growing range: pH 6.5 to 8.1.

Optimum temperature 37° to 40°C. Maximum 46° to 48°C.

Oblicate anaerobe.

Source: Soil, fresh water and marine muds, rabbit feces, sewage. Pure cultures were isolated from fresh water and marine muds (Barker, loc. cit., 1940).

Habitat: Wherever organic matter is decomposing in an anaerobic, approximately neutral environment. Appendix III: Miscellancous species of non-motile, or motile, non-spore-forming rod-shaped bacteria not previously listed or described

Ascobacterium luteum Babes (Babes, in Cornil and Babes, Les Bactéres, 3rd ed., I, 1890, 155, also see Petr., Cent f Bakt., II Abt., 26, 1910, 359) From water in Budapest (Babes) and the olive fly (Petri).

Bacillus a, b, c, d, e, f, h and 1, Vignal (Arch. d. phys norm. et path, Ser 3, 8, 1886, 350-373; also see Flatobacter sum buccalis Bergey et al. and Bacillus buccalis fortutus Sternberg) From salive and the teeth.

Bacillus acido-aromaticus Van der Leck. (Cent. f. Bakt, II Abt, 17, 1907, 652) From milk.

Bacillus aculangulus Migula (No 13, Lembke, Arch. f. Hyg, 29, 1897, 319, Migula, Syst. d Bakt., 2, 1900, 680)

From feees

Bacillus acutus Kern (Arb bakt
Inst. Karlsruhe, 1, Heft 4, 1896, 433)
From the stomach of a bird

Bacillus adametri: Migula. (Bacillus No. XIII, Adametr. Landwirtsch Jahrb., 18, 1889, 246, Migula, Syst d Baht., 2, 1900, 686, not Bacillus adametr. Trevisan, I generi e le spece delle Batteriacce. 1889, 19) From cheese

Bacillus acris Chester (Bacillus tulaccus saccharı Ager, N Y Med. Jour
1891, 265; see Dyar, Ann N. Y Acad
Sci. 8, 1895, 369; Bacterium riolaccous
sacchari Chester, Ann Rept Del Col.
Agr IND. Sta., 9, 1897, 116, Chester,
Man. Determ. Bact., 1901, 260) From
air Produces a violaccus black pigment
in old cultures in milk.

Bacillus aerobius Doyen. (Bacillus urinac aerobius Doyen, Jour d connaiss. m(dic., 1883, 107; Doyen, ibid., 108) From urine.

Bacillus aerogenes Miller. (Miller, Deutsche med. Wehnschr., 12, 1886, 119, see Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1889, 262, not Bacillus aerogenes Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 340.)

Bacillus aerogenes sputigenus capsulatus Herla (Arch. de Biol, 14, 1895, 403; abst in Cent f. Bakt., 25, 1899, 350.) From the blood of a mouse which had been inoculated with the sputum of a pneumonia patient.

Bacillus aeschynomenus Trevisan. (Bacille de l'air J. Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150; Trevisan, I generi e le specie delle Batteriacce. 1889, 20.) From air.

Bacillus aèthebius Trevisan. (Bacille de l'air c, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 149; Trevisan, I generi e le specie delle Batteriacee, 1889, 20) From air.

Bacillus agilis Trevisan (Bacillus der Vagus-Pneumonie, Schou, Fortschr. d Medicin, 9, 1885, No 15: Bacillus nneumonicus gaitis Flürge. Die Mikroorganismen, 2 Aufl., 1886, 262, Trevisan. I generi e le specie delle Batteriacce, 1889, 14: not Bacillus agilis Tschistowitsch. Berl klin Wochnschr., 1892, 512; not Bacillus agilis Chester, Man. Determ Bact . 1901. 226, not Bacellus ambs Mattes, Sitzungsber d Gesells, z. Beforderung d gesam Naturw z. Marburg, 62, 1927, 406, not Bacillus amlis Hauduroy et al , Diet d Bact Path., Paris, 1937, 33. Bacterium pneumonicus agains Chester, Ann Rept Del Col. Agr Exp. Sta , 9, 1897, 110, Bacterium tanus pneumonie Chester, ibid . 144: Eacillus pneumonicus Migula, Syst d. Bakt . 2, 1900, 752 ) From the lungs of rabbits having vacus pneumonia

Bacilius agilis Mattes (Sitzungsber, d. Gesells z Beforderung d. gesam, Naturw z Marburg, 62, 1927, 405.) From the Mediternaean flour moth (Ephesita Luchniella)

Bacillus agillimus DeToni and Trevisan (Bacillus luteus putidus Maggiora, Giorn. d. Soc. 1tal. d'Ignen, 11, 1859, 311; DeToni and Trevisan, in Saccardo, Sylloge l'ungorum, 8, 1889, 969.) From the skin.

Bacillus agnorum Trevisan. (Bacterium subtile agnorum Rivolta, Giorn. di Anat, fisiol. degli anumali, 1881, 31 and 1883, 78; Trevisan, I generi e le specie delle Batteriacce, 1889, 13) Prom discased lambs.

Bacillus alacer Eckstein (Ztschr. f. Forst- u. Jagdwesen, 26, 1891, 13.) Found associated with the eggs of the nun moth (Lymantria monacha).

Bacillus alatus Grieg Smith. (Proc. Linn. Soc New So. Wales, 50, 1905, 570.) Bacillus albatus Kern. (Arb. bakt. Inst Karlsruhe, 1, Heft 4, 1896, 408.) From the stomach and intestines of a

bird.

Bacillus albus Pagliani, Maggiora and Fratim. (Weisser Bacillus, Eisenberg, Bakt. Diag., 1 Auft, 1886, Table 7; Pagliani et al., Giorn d. Soc. ital. d'Igene, 9, 1887, 587; not Bacillus albus Trevisan, 1 generi e le specie delle Batteriacee, 1889, 14, not Bacillus albus Berggy et al., Manual, 3rd ed., 1930, 398; Bacternum albus Chester, Ann Rept. Del Col Agr. Exp. Sta. 9, 1897, 76) From water

Bacillus albus anaerobiescens Vaughan. (Amer Jour Med. Sci., 104, 1892, 191.) From water.

Baciltus athus putidus DeBary. (Quoted from Sternberg, Man of Bact, 1893, 675) From water.

Bacillus albus-putidus Chester (Maschek, see Adametz, Bakt. Nutz u. Trinkwasser, 1888, Chester, Man Determ. Bact., 1901, 237) From water

Bacillus albus putridus Vaughan (Amer Jour Med Sci., 104, 1892, 186)

Bacillus alpha Dyar. (Ann. N. Y Acad Sci., 8, 1895, 366.) From air

Bacillus amabilis Dyar. (Dyar, Ann. N Y Acad Sci., 8, 1895, 358, Bacterium amabilis Chester, Ann. Rept Del. Col. Agr Exp Sta., 9, 1897, 110) From air

Bacillus amarillae Trevisan (Bacille de la fiévre jaune, Babes, in Cornil and Babes, Les Bactéries, 2nd ed . 1886, 529; Trevisan, I generi e le specie delle Batteriacce, 1889, 13.) From a case of yellow fever.

Bacillus amarus Migula. (Bacillus liquefariens lactis amari v. Freudenreich, Landwirtsch. Jahrb. d. Schweiz, 8, 1891; Migula, Syst. d. Bakt., 2, 1800, 691; not Bacillus amarus Hammer, Iowa Agr. Evp. Sta. Res. Bull. 52, 1919, 198.) From bitter milk.

Bacillus amerimnus Trevisan. (Bacille de l'air b, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 149; Trevisan, I generi e le specie delle Batteriacee, 1889, 20) From air.

Bacillus amygdaloides Weiss. (Arb bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 216) From brine on salted pickles.

Bacillus anceps Trevisan. (Bacille du mucus intestinal normat a, Bakes, de Gornil and Bakes, Les Bactéries, 2nd ed, 1886, 153; Trevisan, I generi e le specie delle Batteriacce, 1889, 15.) From normal intestinal mucous.

Bacillus anthraciformis Wilhelmy (Arb. bakt. Inst. Karlsrube, 3, 1903, 28) From meat extract.

Bacillus anthracoides Trevisan. (Bacille de l'air k, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 181; Trevisan, I generi e le specie delle Hatternacee, 1889, 20; not Bacillus anthracoides Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., \$, 1896, 232.) From air.

Bacillus annulatus Zimmermann. (Bakt unserer Trink- u Nutzwasser, Chemnitz, 2, 1894, 30.) From water. Bacillus anularius Henrici. (Arb.

bakt Inst Karlsruhe, 1, Heft 1, 1894, 32.) From Emmenthal cheese.

Bacillus apicum Kruse. (Canestriu, Atti Soc Ven. Trent. Sci. Nat., 12, 1892, 134; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 233) From infected bees and their larvae.

Bacillus apisepticus Burnside. (Jour-Econ. Ent, 21, 1928, 379.) Pathogenic for the honey bee (Apis mellifera)

Bacillus aquatilis Migula (Bacillus

aquatilis sulcatus II, Weichselbaum, Das österreichische Sanitätswesen, 1839, No. 14-23; Bacterium aquattis sulcatus quartus Chester, Ann Rept. Del Col Agr. Exp Sta. 9, 1807, 72; Migula, Syst d. Bakt, 2, 1900, 733, not Bactilus aquatitis Frankland and Frankland, Ztechr i. Hyg., 6, 1895, 381; Bactilus aquatitissulcatus-quartus Chester, Man Determ Bact., 1901, 216) From water

Baullus aquatitis Trevisan (Bacille de l'eau a, Babes, in Cornil and Babes, Les Bacteries, 2nd ed., 1886, 167, Trevisan, I generi e le specie delle Batteriacce, 1880, 19, not Bacillus aquatitis Frank land and Frankland, Zischr f Hyg. 6,

1889, 381 ) From water

Bacillus aqualitis communis Kruse (Kruse, in Flugge, Die Mikroorgansmen, 3 Aufl., 2, 1896, 315, Bacterium aqualitis communis Chester, Ann Rept Del Col Agr. Lvp Sta, 9, 1807, 91) Found commonly in water Lasted by Kruse as a non-chromogenie strain of Bacillus fluorescens liquefacens (Pseudomonas fluorescens liquefacens (Pseudomonas fluorescens liquefacens)

Bacillus arborescens Jamieson and Edington. (Brit. Med Jour, 1, 1887, 1265.) From the descuamation of scar-

let fever patients
Bacillus arboreus Migula

Bacillus arboreus Migula (Baumchenbacillus, Maschek, Bakt Untersuch d Lettmeritzer Trinkwisser, Leitmeritz, 1887, Migula, Syst d Bakt, 2, 1990, 710) From water

Bacillus aromaticus Beijerinek. (Quoted from Yan der Leek, Cent f Bakt, II Abt., 17, 1907, 190, not Bacillus aromaticus Panmel, Bull 20, Iowa Agr Exp Sta, 1803, 792, not Bacillus aromaticus Grimm, Cent f Bakt, II Abt. 8, 1902, 585; not Bacillus aromaticus Van der Leek, loc cit., 650) From milk.

Bacillus aromaticus Van der Leck (Van der Leck, Cent f Bakt, II Abt, 17, 1907, 659.) I rom soft cheeses

Bacillus assimilis Trevisan (Bacille de l'air i, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 130, Trevisan, I generi e le specie delle Batteriacee,

Bacillus aurantius Trevisan (Orangerother Wasserbacillus, Adametz and Wichmann, Mitth. Oest Vers Stat f Brauerei u Malz. in Wien, 1, 1885, 50; Trevisan, I generi e le specie delle Batternacee, 1889, 19, not Bacillus aurantius Bergey et al , Manual, 3rd ed., 1930, 221) From water

Bacillus aureus Eckstein (Zischr. f. Forst- u Jagdwesen, 26, 1891, 9; probably not Bacillus aureus 17:nahland and Frankland, Philos Trans Roy. Soc London, 178, B, 1887, 272 and probably not Bacillus aureus Pansini, Arch f. path Anat. u Physiol, 122, 1890, 436; not Bacillus aureus Adametz, quoted from Sternberg, Man of Bact, 1893, 621) Capable of infecting the larvae of various insects.

(Bakt unserer Trink u Nutrwässer, Chemmitz, 2, 1801, 21) From water. Bacillus bobess Trevisan (Bacille du mucus intestinal normal b, Bubes, in Cornil and Babes, Les Bactéries, 2nd ed , 1886, 183, Trevisan, I generi e le specie delle Batteriacee, 1889, 15) From normul intestinal mucus

azureus

Zimmermann

Racillus

Bacillus beljantu Migula (Line neue pathogene Bakterumart um Tetanusmaternal, Belianti and Peccarolo, Cent. f Bakt., 4, 1888, 513, Bacillus accudentalis tetani Kruse, in Flügge, Die Mikhoorganismen, 3 Aufl. 2, 1876, 433, Bacteruma accidentalis tetani Chester, Ann Rept Del Col Agr Exp Sta. 9, 1877, 88, Migula, Syst d Bakt. 2, 1900, 767; not Bacillus beljanti Carlione and Venturelli, Boll 1st Sieroter, Milan, 4, 1925, 57, Bacillus accidentalis Chester, Man Determ Bact., 1901, 229) From pus in a cise of tetanus

Bacillus benzoli Tausson (Planta, 7, 1929, 735) From soil Oxidizes benzene

Bacillus berilericus Trevisan, (Caratt di ale nuov gen di Batt, 1885, 12) From eases of beri beri in Japan Also see Ogata, abst. in Cent. f. Bakt., \$, 1888, 75.

Bacillus berolinensis Migula. (Roter Bacillus aus Wasser, Fraenkel, Grundriss der Bakterienkunde, 3 Aufl, 1890, 252; Bacillus ruber berolinensis Kruse, in Flugge, Die Mikrooganismen, 3 Aufl., 1890, 303; Bacterium ruber berolinensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 113; Migula, Syst. d. Bakt., 2, 1900, 856; not Bacillus berolinensis Chester, Man. Determ. Bact., 1901, 305.) From water. Rust-red to orange-yellow pigment on potato.

Bacillus beta Dyar. (Ann. N. Y Acad Sci., 8, 1895, 366.) From air.

Bacillus beyerinch: DeToni and Trevisan (Bacillus radicicola var. liquefaciens Beijerinck, Bot. Zeitung, 1883, 750; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 972; not Bacillus beijerinchi: Henneberg, Ztschr. f. Spiritusindustrie, 26, 1903, 22; see Cent. f. Bakt., II Abt., 11, 1903, 150.) From soil and the roots of legumes.

Bacillus bilingsi Chester. (Bacillus of corn-stalk disease of cattle, Billings, in Baumgarten, Jahresbericht, 1889, 184; Chester, Man. Determ. Bact., 1901, 214) Isolated by Billings from corn-stalk disease of cattle, and by Nocard from bronchopneumonia in oxen

Bacillus bombycis Chatton (Chatton, Compt. rend. Acal Sci., Paris, 168, 1913, 1708; not Bacillus bombycis Macchati, Stazioni sperimentali Agrarie Italiane, 20, 1891, 121; Bacterium bombycis Paillot, L'infection chez les insectes, 1933, 131.) From diseased silkworms (Bombyz mori)

Battlus booker Dyar, Chyar, Ann N. Y Acad. Sci., 8, 1895, 378, not Bacillus booler: Ford, Studies from the Royal Victoria Hospital, Montreal, 1, 1903, 31.) Found by Dr. Prudden in a case of cystitis.

sa Giorn Sc DeTom an Sylloge Fungorum, 8, 1889, 967.) From the skin.

Bacillus brunneus (Schrocter) Schroe-(Bacteridium brunneum Schroeter. in Cohn, Beitr, z. Biol. d. Pflanz., 1, Heft 2, 1872, 126; Schroeter, in Cohn. Kryptog. Flors v. Schlesien, 3 (1), 1886, 158; not Bacillus brunneus Adametz and Wichmann, Die Bakt, der Nutz- und Trinkwässer, Wien, 1883; Bacıllus fuscus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 290; not Bacillus fuscus Zimmermann, Bakt. unserer Trink- u. Nutzwasser, Chemnitz, 1, 1890, 70.) Bacterium brunneum Schroeter or Cohn is given as a synonym by Flugge (1886) and by Trevisan (1889) but this appears to be an incorrect spelling of Bacteridium brunneum Schroeter. Neither Schroeter nor Cohn used Bacterium brunneum in 1872 or later so far as can be determined by a careful study of their papers. From corn, wheat and potato infusions.

Bacillus buccalis forfuitus Sternberg (Bacillus i, Vignal, Arch, Phys. norm. et path., Sér. 3, 8, 1886, 337; Sternberg, Man. of Bact., 1893, 685; Bacterium bucalis (sic) fortuitus Chester, Ann Rept. Del. Col. Agr. Evp. Stn. 9, 1897, 91 and 130, Bacıllus bucalis (sic) Chester, Man. Determ Bact., 1901, 234; not Bacullus buccalis Trevisan, I generi e le specie delle Batteriacee, 1889, 15) From the mouth.

Bacillus buccalis muciferens Muler. (Miller, Dental Cosmos, 33, 1891, 792 and 800.) From the blood. A slimy capsulated bacillus

Bacillus buccalis septicus Miller. (Miller, Dental Cosmos, 35, 1891, 792 and

butyri I, v. Klecki, Cent. I. Bakt., 16, 1894, 357; Migula, Syst. d. Bakt., 2, 1900, v and 811) From rancid butter.

Bacillus caeci Ford. (Studies from the Royal Victoria Hosp., Montreal, 1, (5), 1903, 45, also see Jour Med Res. 1, 1901, 217.) From the stomach and rectum.

Bacillus canalensis Castellam (Proc Soc. Exp Biol, and Med., 25, 1928, 540) From human feces.

Bacillus canus Migula. (Grauer Bacillus, Maschek, Untersuch d Leitn eritzer Trinknässer, Leitmentz, 1887, Migula, Syst. d. Bakt., 2, 1900, 711) From water.

Bacillus canus Eckstein (Ztschr f Forst- u Jagdwesen, 24, 1891, 15) From larvae of the nun moth (Lymantria monacha.)

Bacillus carabiformis Racryschi (Diss. milit medic Acad Petropolitanae Ruteniae, 1888; abst in Cent f Bakt, 6, 1889, 113.) From the stomach of a doc

Bacillus carnis Wilhelmy (Wilhelmy, Arb bakt, Inst. Karlsruhe, 5, 1903, 21, not Bacillus carnis Klein, Cent f Bakt, II Abt, 35, 1903, 459) From meat extract.

Bacillus caseolyticus Lochmann (Cent f. Bakt, I Abt, Orig, 51, 1902, 385.) From the organs of gunea pigs which had been inoculated with tubercle bacilli.

Bacillus cathetus Trevisan (Bacille de l'air g, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150, Trevi san, I generi e le specie delle Batteriscee, 1889, 20) From air.

Bacillus casiae Trevisan. (Bacille du mucus intestinal normal du cobase e, Babes, in Cornil and Babes, Les Bac-téries, 2nd ed., 1880, 164; Trevisan, I genere ic les pecie delle Batteriacce, 1889, 15; Pasteurella carace DeTona and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 906; not Pasteurella carace Hauduroy et al., Diet d. Bact Path, 1937, 193.) From the intestinal mucus of guines pies.

Bacillus centralis Zimmermann (Bakt, unserer Trink, u Nutzwässer, Chemnitz, 2, 1591, 10) From water

Bacillus charrins Trevisan (Bacille

de la pseudo-tuberculose bacillaire du cobaye, Charrin and Roger, Compt rend Aead, Sci, Paris, 107, 1888, 868, Trevisan, I generi e le specie delle Batteriacce, 1889, 13.) From pulmonary tuberculosis of guinea pies

Bacillus chlornus Migula (Gringelber Bacillus, Tataroff, Inaug Diss, Dorpat, 1891, 50, Migula, Syst d Bakt, 2, 1900, 820, not Bacillus chlornus Frankland and Frankland, Phios Trans. Roy. Soc London, 178, B, 1887, 271) From water.

Bacillus chyluriae Trevisan (Bacillus of chyluria, Wilson, Brit. Med. Jour., No. 1249, 1884, 1128, Trevisan, Atti Acad Med Fis -Stat Milan, Ser. V., 5, 1885, 99) From chyluria.

Bacillus citreus (Unna and Tommasoli) Kruse (Acobacillus citreu Unna and Tommasoli, Monsts I prakl Dermetol., 9, 1890, 50, Kruse, nr Hugge, Die Mikroorganismen, 3 Aufl., 2, 1876, 309, not Bacillus citreus Frankland and Trankland, Pholos Trans Roy Sov., London, 178, 1887, 18, 272, Pacterium citreus Chester, Ann Rept Del Col Agr. Exp Sta., 9, 1877, 104) Trom the human skin in cases of exercis

Bacillus citricus Kern. (Kern, Arb bakt Inst Karlstuhe, I. Heft 4, 1896, 426, not Bacillus citricus Wers, ibid, 2, Heft 2, 1902, 234) From the intestines of birds

Bacillus citrinus Migula (Citrongelber Bacillus, Maschek, Bikt Untersuch d Leitmentzer Trinkwasser, 1887, Migula, Syst d Bakt, 2, 1990, 832.). Tronwater

Bacillus cladogenes Trevisan (Bactérie de l'air No 3, Babes, in Cormi and Bales, Les Baciéries 2nd ed., 186, 140, Trevisan, I generi e le specie delle Batteriacce, 1889, 20 ). From air.

Bacillus clariformis Doyen (Bacillus urinne clariformis Doyen, Jour. d. connsiss médic, 1889, 106, Doyen, ibid., 108, Bacillus dajeni DeToni an I Tresisan, in Saccardo, Sylloge Fungorum, 8, 1889, 949.) From urine.

Bacıllus cleoni Picard. (Bull. Soc. d'Étude et de Vulgarisation Zool. Agric., 12. 1913, 134.) A fluorescent coccobacillus. From diseased larvae of weevils (Temnorrhinus (Cleonus) mendicus).

Bacillus coccineus Catiano (Catiano. in Cohn, Beitr. z. Biol. d. Pflanz., 7. 1896, 339; not Bacillus coccineus Pansini, Arch. f. path. Anat , 122, 1890, 437; Bacillus subcoccineus Migula, Syst. d. Bakt , 2, 1900, 857.) From the vagina. Reddish pigment.

Bacillus coerulea-viridis Trevisan. (Blauerûn fluorescirende Baeterium. Adametz, Mitth. Oest. Vers Stat. f. Brauerei u. Mälz. in Wien, 1, 1888, 46; Trevisan, I generi e le specie delle Batteriacce, 1889, 20: Bacterium cocrulcoviride DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1087.) From water.

Bacillus coeruleus Eckstein, (Eckstein, Ztschr f. Forst- u. Jagdwesen, 26. 1894, 14; not Bacillus coeruleus Smith, Med News, 1887, 758; probably not Bacillus cocruleus Voges, Cent. f. Bakt , 14, 1893, 301 ) From larvae of the nun

moth (Lymantria monacha).

Bacıllus columbarum Chester. cillus of pigeon cholera, Moore, U.S. D.A., Bur Anim. Ind , Bull. 8, 1895; Chester, Man Determ, Bact., 1901, 209.) From a disease of pigeons. Hadlev et al (Rhode Island Agr. Exp Sta, Bull 174, 1918, 178) regard this as probably a paracolon.

constructus Bacillus Zımmermann. (Zimmermann, Bakt. unserer Trink- u. Nutznässer, Chemnitz, 1, 1890, 42, Bacterium constrictus Chester, Rept. Del. Col Agr. Exp. Sta , 9, 1897,

112) From water

Bacillus convolutus Wright (Wright. Mem. Nat. Acad Sci., 7, 1895, 461; Bacterium contolutus Chester, Ann. Rept. Del. Col Agr Exp Sts., 9, 1897, 101.) From river water.

Bacillus coprogenes foetidus Sternberg.

(Darmbacillus, Schottelius, 1885; Stern. berg, Man. of Bact., 1893, 468 ) From the intestinal contents of pigs which had died of swine erysipelas.

Bacillus coronatus Keck. (Inaue Diss., Dorpat, 1890, 43) From water. Bacillus corví Kern. (Arb. bakt, Inst. Karlsruhe, 1, Heft 4, 1896, 394.) From

the stomach and intestines of birds. Bacillus courmontii Migula. (Courmont, Compt. rend. Soc. Biol., Paris. 1889; Bacillus pseudotuberculosis similis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 454; Migula, Syst. d. Bakt., 2, 1900, 770.) From tubercles of cattle.

Bocillus crassus Lucet. (Bacıllus crassus puogenes boris Lucet, Ann. Inst. Past , 7, 1897, 327; Bacillus crassus pyogenes Lucet, ibid., 327; Lucet, ibid., 328; Bacillus pyogenes crassus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2. 1896, 343; Bacterium pyogenes crassus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 141; Bacillus boris Migula, Syst. d. Bakt., 2, 1900, 765.) From bovine abscesses. Regarded by Kruse as a synonym of Bacillus pneumoniae

Bacillus crinitus Migula. (No 15, Lembke, Arch. f. Hyg., 29, 1897, 321; Migula, Syst. d. Bakt., 2, 1900, 678) From feees.

Bacillus cubonianus Cuboni and Garbini. (Atti. dei Lincei, Scr. 4, 6, 1890, 26-27, quoted from Steinhaus, Bact. Assoc. Extracell, with Insects and Ticks, Mianespolis, 1942, 53, not Bacillus cubonianus Macchiati, Staz. Sperim. Agr. Ital., 23, 1892, 228.) From silkworms (Bombyz mori).

Bacillus cuenoti Mercier. (Bakteri-Gebilden, Blochmann, enähnlichen Ztschr. f. Biol., 24, 1887, 1; Compt. rend. Soc. Biol., Paris, 61, 1906, 682; also in Arch. f. Protistenkunde, 9, 1907, 346) From the fat body of the cockroach (Periplaneta orientalis).

Bacillus cunsculi Migula. (Bacillus septicus cuniculi Lucet, Ann. Inst. Past., 6, 1892, 564; Bacillus cuniculi septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl . 2, 1896, 406, Bacterium euniculi senticus Chester, Ann. Rent. Del. Col. Agr. Pap Sta . 9, 1897, 76; Migula, Syst d. Bakt . g. 1900, 758 ). Associated with a apontaneous epizootic of rabbuts

Racillus envienheida sumalulus Kruso (Kruse, in Phone Die Mitroorganis men, 3 Aufl., 2, 1896, 417. Bacterium cunsculicida immobiles Chaster Ann Rent Del Col Agr. Exp Sta . 9 1897 84: Bacterium consculseida var ammabile Chester, Man Determ Bact 1901, 140 ) Cause of a disease of rabbits

Bacillus custiformis Clado (Onoted from Sternberg, Man of Bact, 1893. 649) From urine in a case of exstitis

Bacillus enstitudis Migula (Cocco bacillus aerogenes resicae Schow, Cent f Bakt . 12. 1802. 749. Racillus aerogenes testede Lehmann and Neumann, Bakt Diag., 1 Aufl. 2, 1896, 237, Bacterium gerogenes tenege Chester, Ann Rent Del Col Agr. Exp. Sta. 9, 1897, 128, Migula, Syst d Bakt . 2, 1900, 771, Bacillus gerogenes Chester, Man Determ Bact , 1901, 227, not Bacillus aerogenes Miller, Deutsche med Wochnschr. 12, 1886, 119, not Bacillus aerogenes Kruse, in Plugge, Die Mikroorganismen. 3 Aufl. 2, 1896, 340 | From urine in a case of evstitis

Bacillus dacryoideus Migula (Bacillus oogenes hydrosulfureus n. Zorkendörfer, Arch f. Hyg. 16, 1893, 389, Migula, Syst d Bakt . 2, 1900, 791 From hene' eggs

Bacillus decolor Lekstein. (Zitschr f Forst- u Jagdwesen, 26, 1894, 15 From the larvae of a butterfly (Vanessa utricae)

Bacıllus decolorans major Dyar (Ann. N Y. Acad Sci. 8, 1895, 362) From air

Bacillus decolorans minor Dyar (Ann N Y Acad Sci. 8, 1895, 359) From air

Bacıllus defessus Kern (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 397.) From the stomach and intestines of birds

Bacillus delta Dyar, (Dyar, Ann.

N Y Acad Sci., 8, 1895, 368, Bacterium delta Chester Ann. Rent. Del. Col. Agr. Exp. Sta. 9, 1897, 111 ) From water

Bacillus denterficans Giltax and Aber-(Giltav and Aberson, Arch, Neerl Ser exact et nat . 25, 1891, 341, quoted from Sternberg, Man of Bact, 1893. 727 not Bacillus denterficans Migula Syst d Bakt . 2, 1900, 796, not Bacillus denterficans Chester Man Determ Bart 1901, 274) From soil and air

Racillus dentrofluorescene van Iterson (Cent f Bakt H Abt 9 1902 772 19 1904, 111) Pluorescent From soil. Racillus deptales condans Miller (Miller, Die Mikroorganismen der Mundhoble, Leipzig, 1889, 218 ) From earlous

teeth Bacillus dermoides Tataroff (Inaug Diss. Dorpat, 1891, 19) From water

Bacillus diaphanus Migula (Halıhacterium nellucidum Fischer, Die Bakterien des Meeres, 1891, 22, Migula, Syst d Bakt. 2 1900, 712.) From sea water

Bacillus diffuens Doven (Bacillus urange diffluens Doven, Jour d' connaiss médie . 1889, 107, Doven, abid . 108, not Rocallus defluens Castellani, 1915, sec Castellam and Chalmers, Man Trop Med , 3rd ed , 1919, 913 ) From urine Bacillus digitatus Migula (Bacillus No 7, Pansini, Arch f path Anat, 122,

1890, 443, Migula, Syst d Bakt , 2, 1900, 659 ) From sputum

Bacillus dissimilis Trevisan (Bacillus I. Leube, Arch f path Anat, 100, 1885, 556, Trevisan, I generi e le specie delle Batteriacee, 1889, 16 ) From urine

Bacillus domesticus Dyar (Dyar, Ann N Y Acad Sci. 8, 1895, 359. Bacterium domesticus Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 110 ) From air

Bacillus droserae (Troili-Petersson) Buchanan and Hammer. (Bacterium droserae Troili-Petersson, Cent f Bakt . II Abt . 58, 1913, 1, Buchanan and Hammer, Iowa Sta Coll Agr. Evp Sta, Res Bull 22, 1915, 256 ) Isolated by placing leaves of a sundew (Droscra intermedia) in milk and isolating the

slimy milk organisms developing. Closely related to Bacterium lactorubefaciens Gruber, according to Buchanan and Hammer.

Bacillus duclauxii (Miquel) DeToni and Trevisan. (Urotacillus duclauxii Miquel, Ann. d. Microgr., 2, 1889, 58; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 963) From seware.

Bacillus eczemicus Trevisan. (1 generi e le specie delle Batteriacec, 1889, 14.) From evudate in cases of eczema.

Bacillus egregius Zopf. (Quoted from Papenhausen, Arb. bakt. Inst. Karlsruhe, 3, 1903, 59.) A reddish-yellow non-spore-forming rod

Bacillus elepsoideus Migula. (Bacillus saprogenes vini v, Kramer, Die Bakterien in ihren Beziehungen zur Landwirtschaft, 2, 1892, 138; Migula, Syst d. Bakt., 2, 1900, 684.) From wine

Bacillus ellinglonii Chester. (Bacillus No 21, Conn., Rept. Conn. (Storrs) Agr. Exp. Sta., 1893, 52, Chester, Man Determ. Bact., 1901, 264) From milk.

Bacillus emmans Weiss (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 232.) From vegetable infusions

Bacillus emulsinus Fermi and Montesano. (Cent f Bakt, 15, 1894, 722) From air. Decomposes amygdalin

Bacillus endocarditidis Migula (Bacillus endocarditidis griseus Weichselbaum, Beitr. z. path. Anat., 1, 1889, 119, Bacterium endocarditidis griseus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 88, Migula, Syst d. Bakt., 2, 1900, 750.) From a case of endocarditis

Bacillus engelmann Trevisan (Bacterium chlorinum Engelmann, see Flügge, Die Mikroorganismen, 2 Anß., 1886, 289; not Bacterium chlorinum Migula, Syst d. Bakt. 2, 1900, 471, Trevisan, I generi e le specie delle Batternacee, 1889, 18) Source not given.

Bacillus enteromyces Trevisan (Bacille des selles f. Habes, in Cornil and Babes, Les Bactèries, 2nd ed., 1886, 154; Trevisan, I generi e le specie delle Batteriacce, 1889, 15) From feces. Bacillus entomotoxicon Duggar. (Bull Illinois State Lab. Nat. Hist., 4, 1886, 340-379.) From the squash bug (Anasa tristis),

Bacillus epsilon Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 369; Bacterium epsilon Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 114.) From air.

Bacillus equi Migula (Bacillus equi intestinalis Dyar and Keith, Technol Quarterly, 6, 1893, No. 3; abst. in Cent. I. Bakt., 16, 1891, 838; Bacterium equi intestinalis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 70; Migula, Syst. d. Bakt., 2, 1900, 874; Bacillus intestinalis Chester, Man. Determ. Bact., 1901, 213.) From the intestines of a horse.

Bacillus crubescens Migula. (Bacillus oogenes hydrosulfureus x, Zörkendörler, Arch. I. Hyg., 16, 1893, 391; Migula; Syst. d. Bakt, 2, 1900, 792; Bacillus rubescens Nepveux, Thèse, Fac. Pharm. Paris, 1920, 113.) From hens' eggs.

Bacillus crythrogenes rugatus Dynr. (Ann. N. Y. Acad. Sci., 8, 1895, 374) A wrinkled variety of Bacillus lactis eruthrogenes Hueppe.

Bacillus erythrosporus Millet. (Millet, in Cohn, Beitr. 2. Biol. d. Pflant., 3. Heft 1, 1879, 135; Bacillus (Streptbacter) erythrospores (sic) Schroeter, in Cohn, Krypt. Flora v. Schlex., 5, 1, 1886, 185; Bacterium erythrosporus Chester, Ann. Rept. Del. Col. Agr. Lyp. Sta., 5, 1871, 123) From putrelying egg-white and meat infusion. According to Chester, the author mistook reddish granules for spores. Fluorescent.

Bacillus esterificans fluorescens Massen. (Arb. a. d. k. Gesundsheitsamte, 18, 1899, 501-507.) From grains and from rotting vegetation in river water. Bacterium esterificans stralauense Mas-

Bacterium externicans strandardisante, sen. (Arb. a. d. k. Gesundheitsante, 15, 1599, 501-507.) From Spree River water

Bacillus eta Dyar (Dyar, Ann N Y. Acad. Sci , 8, 1895, 374; Bacterium eta Chester, Ann. Rept. Del. Col Agr Evp Sta , 9, 1897, 107) From air

Bacillus ethaceticus Frankland and

Frankland. (Proc. Roy. Soc. London 46, 1889.) Ferments mannitol, glycerol and glucose to ethyl alcohol and acette acid with a trace of formic and succinic soids.

Bacillus ethacetosuccinicus Frankland and Frew. (Transactions of the Chemcal Society, 1892, 275.) Ferments mannitol and dulcitol to ethyl alcohol, acetic acid, succinic acid, hydrogen and car honic acid.

Bacillus ezapatus Trevisan (Bacillus der conjunctivalsack f, Fick, Ueber Mikroorg in Conjunctivalsack, Wiesbaden, 1887; Trevisan, I generi e le specie delle Batteriacee, 1889, 15) Found frequently in the human ev

Bacillus eriguus Wright (Wright, Mem. Nat. Acad Sci. 7, 1805, 447, Bacterium eziguum Chester, Ann Rept Del. Col. Agr. Evp Sta. 9, 1897, 114, not Bacterium eziguum Stäubli, Munch ner med. Wochnschr., No. 45, 1905) From water.

Bacillus famıger Trevısan. (Bacıllus bei Lrysipel am Kaninchenohr, Flügge, Die Mikroorganısmen, 2 Auft, 1886, 283, Trevisan, I generi e le specie delle Batteriacce, 1889, 14.) From a case of crysipelas of the ear of a rabbit.

Bacillus felts (Rivolta) Trevisan (Cocco-bacterium felts Rivolta, Giorn di Anatomia, No. 1, 1883; Trevisan, I generi e le specie delle Batteriacco, 1889, 14.) From an infection in a cat

Bacillus fermentationis Chester (Bacillus foetidus liquefaciens Tavel, Ueber d. Actiol. d. Strumitis, Basel, 1872, Chester, Man. Determ. Bact, 1901, 233) From strumitis.

Bacillus ferrugineus Rullimann (Rullimann, Cent. f Bakt, I Abt, 24, 1878, 467; not Racillus ferrugineus Varr Iterson, Cent. f. Bakt., II Abt., 11, 1803, 694) From canal water.

Bacillus ferrugineus Dyar, (Dyar, Ann. N. Y. Acad. Sci., 8, 1805, 361, not Bacillus ferrugineus Rullmann, Cent. f Bakt., I Abt., Orig., 24, 1803, 465, Bacterium furrugineus (sic) Chester, Ann. Rept. Del. Col. Agr. Exp. Sts., 9, 1877, 115, Bacterium ferrugineum Chester, Man. Determ. Bact., 1901, 177) From air and from a fresh leaf of the pitcher plant (Spracence Augustus)

Bacillus fertilis DeTom and Trevisan. (Bacillus urinae fertilis Doyen, Jour d. connaiss médic, 1889, 107, DeTom and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 949). From urine

Bacillus figurans Vaughan. (Vaughan, Amer Jour Med Sci. 104, 1892, 107; not Bacillus figurans Crookshank, Man. of Bact, 1st ed., 1886) From water.

Bacillus finitimus ruber Dyar (Ann. N Y Acad Sci. 8, 1895, 361.) From air

Bacallus fandescens Migula (Bacillus aguatilus sulcatus v. Weichselbaum, Das österreichische Sanitatsweich, 1889, No 14-23, Bacallus aguatilus sulcatus Krust-23, Bacallus aguatilus sulcatus Krust-23, Bacallus aguatilus sulcatus Aguatilus, in Flügge, De Mikroorganismen, 8 Aufl. 2, 1896, 382; Migula, Syst d Bakt. 2, 1900, 731, Bacallus uerchsellaumis Chester, Man. Determ Bact. 1901, 288. From water

Bacillus flavoides Castellani. (Proc. Soc Exp Biol and Med , 25, 1928, 539.)
From the human skin

Bacillus flatus Eckstein (Zitschr f. Forst. u Jagdincen, 26, 1894, 12, not Bacillus flatus Fuhrmann, Cent. f. Bakt, 11 Abt, 19, 1907, 117, not Bacillus flatus Bergey et al, Manual, 1st ed., 1923, 286) From dead larvae of a butterfit (Yanessa polychlorus)

Bacillus flexuosus Wright (Wright, Mem Nat Acad Sci. 7, 1895, 460; Bacterium flexuosus Chester, Ann. Rept. Del Col Agr Exp Sta. 9, 1897, 100) From mer water

Bacillus flocrosus Kern (Kern, Arb bakt Inst Karlsruhe, I, Heft 4, 1806, 421, nut Bacillus flocrosus Weinberg et al, Les Microbes Ana(robies, 1937, 698) From the stomach and intestines of birds.

Bacillus fluidif cans DeToni and Trevisan (Bacillus fluidif cans partus Maggora, Gora. Soc. ital. d'Igiene, 11, 1859, 311, DeToni and Trevisan, in Seccardo, Sylloge Fungorum, 8, 1889, 969.) From the skin Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 1, 1890, 50; Bacillus gracilior Migula, Syst. d. Bakt., 2, 1900, 664.) From the stomach and intestines of birds.

Bacillus gracilis aerobiens Vaughen. (Amer. Jour. Med. Sci., 104, 1892, 187.) From water.

Bacillus gracilis anaerobiescens Vaughan. (Amer. Jour. Med Sci., 104, 1892, 187.) From water.

Bacillus gracilis cadaieris Sternberg. (Sternberg, Man. of Bact., 1893, 733; Bacterium gracilis cadveris Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 0, 1897, 84.) From the haman liver.

Bacillus grandis Trevisan. (Bacille de l'air h, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 180, Trevisan, I generi e le specie delle Batteriacee, 1889, 20) From air.

Bacillus granulatus Chester. (Bacillus aquathis solidus Lustig, Duag. Bakt. d. Wassens, 1893; Bacterum aquatilis solidus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 76; Chester, Mnn. Determ. Bact., 1901, 223) From water.

Bacillus granulosus Losski, (Losski, Inaug Diss., Dorpat, 1893, 25; not Bacillus granulosus Russell, Ztschr. f. Hyg., 11, 1892, 99; not Bacillus granulosus Gerstner, Arb bakt Inst. Karlsruhe, 1, Heft 2, 1894, 167, Bacillus subgranulosus Migula, Syst. d Bakt., 2, 1900, 820) From sand on the Riga coast

Bacillus graceolens Bordoni-Uffreduzzi (Bordoni-Uffreduzzi, Fortschr. d. Med., 4, 1886, 157, not Bacillus graveolens Russell, Zischr f Hyg., 11, 1892, 99; not Bacillus graveolens Gottheil, Cent. f. Bakt., II. Abt., 7, 1901, 406; Bacterium graceolens Eisenberg, Bakt. Diag., 3 Aufl., 1891, 108.) From skin between the toes

Bacillus gravitzi Trevisan (Bacillus der Acne Contagiosa des Pferdes, Dieckerhoff and Gravitz, Arch. f path Annt., 102, 1885, 148; Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 13, Bacillus acnes contagiosae Kruse, in Flügge, Die Mikroorganismen, 3 Aufl.,

2, 1896, 445; Bacterium acnes contagiosae Chester, Ann. Rept. Del. Col. Agr. Evp. Sta. 9, 1897, 89; Bacterium acnes Migula, Syst. d. Bakt., 2, 1900, 385 Bacterium granitzii Chester, Man Determ. Bact., 1901, 164.) From acne pustles in horses.

Bacillus griseus Migula. (Grauer Bacillus, Keck, Inaug. Diss., Dorpat, 1891, 51; Migula, Syst. d. Bakt., 2, 1900, 785)

From water.

Bacillus haematoides Wright. (Wright, Mem. Nat. Acad. Sci., 7, 1895, 448; Bacterium haematoides Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 115) From river water.

Bacillus hojeli Trevisan. (Bacillus foetidus ozaenae Hajek, Munch med. Wochnschr., 1887 and Berliner kin. Wochnschr., 1888, 662; Trevisan, I geneti e le specie delle Batternacee, 1889, 16; Bacillus ozaenae Migula, 83st. d. Bakt., 2, 1900, 645; not Bacillus ozaenae Abel, Cent. f. Bakt., 18, 1893, 167; Bacterium foetidus ozaenae Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 2, 1897, 134.) From nasal mueus in human ozena.

Bacillus halobicus Horowitz-Wiassowa. (Ztschr. f. Unters. d. Lebensm., 62, 1931, 597) From brines used in salting fish.

Bacillus halophilus Russell. (Russell, Ztschr. f. Hyg., 11, 1891, 200; Bacterium halophilus Chester, Ann. Rept. Del. Col. Agr. Eyp Sta, 9, 1897, 93 and 135) From sea water and marine mud.

Bacillus havaniensıs Migula. (Bacillus havaniensis liquefaccus Steenberg, Man. of Bact., 1893, 686; Bacterium havaniensıs liquefacciens Chester, Ann. Rept. Dol. Col. Agr. Exp. Sta., 9, 1897, 97; Migula, Syst. d. Bakt., 2, 1900, 725, not Bacillus havaniensus Sternberg, loc. ctt, 718) From the shin.

Bacillus helvolus granulatus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 374) Apparently a variety of Bacillus helcolus

Zimmermann.

Bacellus haminecrobiophilus Arloing. (Compt rend. Acad. Sci., Paris, 107, 1888, 1169 and 108, 1889, 458.) From the lymph glands of an experimental guinea pig.

Bacillus hepaticus fortuitus Sternberg. (Sternberg, Man of Bact, 1893, 649, Bacterium hepaticus fortuitus Chester, Ann. Rept Del Col. Agr Exp Sta, 9, 1897, 136) From the liver of a yellowfever cadaver.

Bacillus herrmanni Migula (Ein neuer Kapselbazillus, Herzfeld and Herr mann, Hyg. Rundschau, 5, 1895, 642, Migula, Syst d. Bakt, 2, 1900, 647) From a nasal secretion

Bacillus hofmanni Migula (Hofmann, Wochnschr f Forstwirtsch, 1831, No 1-6 and No 35-39, Migula, Syst d Bakt, 2, 1900, 742) From the larvae of the nun moth (Lymantria monacha)

Bacillus hudsonii Dyar (Ann N Y. Acad Sci, 8, 1895, 369, Bacterium hudsonii Chester, Ann. Rept Del Col Agr Exp Sta, 9, 1897, 106) From air

Bacillus humitis Trevisan (Bactérie de l'air No 1, Babes, in Cermi and Babes, Les Bactéries, 2nd ed, 1886, 140, Trevisan, I generi e le specie delle Batteriacce, 1889, 20 ) From air.

Bacillus hydrocharis Trevisan (Bacille de l'eau c, Babes, in Cornil and Babes, Les Bactéres, 2nd ed., 1886, 168; Trevisan, I generi e le specie delle Batteriacee, 1889, 19) From water

Bacillus hydrosulfureus Migula (Bacillus oogenes hydrosulfureus f Törkendörfer, Arch f. Hyg., 16, 1893, 388, Migula, Syst d Bakt, 2, 1900, 695) From hens' eggs

Bacillus teleogenes Kruse. (Guarmeri, Acc. med Homa, 87/88 and Vincent, Semaine médicale, 1893, 29, Kruse, in Flügge, Die Mikroorganismen, 3 tuft, 2, 1896, 572, Bacterium tetrogenes Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 69) From the liver and blood in cases of facute yellow atrophy

Bacillus incanus Pohl (Pohl, Cent Bat, 11, 1892, 112, Bacterium incanus Chester, Ann Rept Del Col Agr Exp Sta. 9, 1897, 99, Bacterium incannum (sic) Chester, Man Determ Bact., 1901, 157). From swamp water. Bacillus indigogenus Alvarez. (Alvarez, Compt. rend Acad Sci., Paris, 105. 1857, 286, Bacterum indigogenus Chester, Ann Rept Del Col Agr Evp. Sta., 9, 1807, 136.) From an infusion of leaves of the indigo plant.

Bacillus innesi Trevisan. (Bacille de l'éléphantiasis des Arabes, Innes, Bull lst. Égypt de 1886, Cairo, 1887; Trevi san, I generi e le specie delle Batteriacce, 1889, 13.) From the blood in cases of elephantiasis in Egypt

Bacillus inodorus Trevisan (I generi e le specie delle Batteriacce, 1889, 16) From pus

Bacillus intestants motifis Sternberg, (Sternberg, Man of Bact, 1833, 619, Bacterium intestants motifis Chester, Ann Rept Del Col Agr Exp Sta., 9, 1897, 74) From intestance of yellow fever eadavers

Bacillus inutilis Dyar (Ann N. Y. Acad Sci., 8, 1895, 364) From mir.

Bacillus Lappa Dyar (Ann N Y. Acad Sci. 8, 1895, 375) From diseased larva of a moth (Scolioptery libatrix). Bacillus Ilebsii Trevisan (Bacillus

Bactium ricosii rrevisan (Bactium ricosii rrevisan (Bactium ricosii rrevisan (Bactium riso) and Arch f exper. Pathol u Pharmae, JS, 1881, Heft 5-6; Trevisan, Car di ale nuov gen di Battr., 1885, 10, Trevisan, I generi e le specia delle Batterisece, 1899, 14; not Bactium ricosii Ricosii

Bacillus Llecku Migula (Bacillus butyri II, v Klecki, Cent f Bakt, 15, 1801, 300, Migula, Syst d Bakt, 2, 1900, 810) From rancid butter

Bantlus Henni Trevisan (Bacillus de la duribhe chleenforme, Klein, Miro organisms and Discase, 1885, 87; Trevisan, in DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1890, 916, not Bacillus Henni Migula, Syst. d Bakt. 2, 1900, 766, on Bacillus Heinii Buchavian and Hammer, Iowa Agr. Exp Sta Res Bull 22, 1915, 2760 From the blood in fatal cases of choleraic distribucia.

Bacillus Heinis Migula. (Ein neuer

Bacillus des malignen Ocdems, Klein, Cent. f. Bakt., 10, 1891, 186; Bacillus rseudo-oedematis maligni Sanfelice. Ztschr. f. Hyg., 14, 1893, 353; Bacillus cedematis aerobicus Sternberg, Man. of Bact., 1883, 465; Bacillus oedematis aerobius Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 244; Bacterrum oedematis aerobius Chester, Ann. Rept. Del. Col. Agr. Exp. Sta , 9, 1897, 75; Migula, Syst. d. Bakt., 2, 1000, 766; not Bacillus kleinti Trevisan, in De-Toni and Trevisan, in Saccardo, Sylloge Fungarum, 8, 1889, 946; not Bacillus Meinti Buchanan and Hammer, Iowa Agr. Exp. Sta. Res. Bull. 22, 1915, 276; Bacillus acrobius Chester, Man. Determ. Bact, 1901, 221.) From a guinea pig inoculated with soil.

Bacillus kornfi Chester. (Barillus bei einem Leberabscess, Korn, Cent. f. Bakt., 21, 1897, 438; Chester, Man. Determ. Bact., 101, 252) From a case of

liver abscess.

Bacillus locis Chester. (Racillus b, Guilicheau, Ann. Microg., 11, 1898-1899, 225, Chester, Man Determ Bact., 1901, 238; not Bacillus lacts Neide, Cent. f. Bakt., 11 Abt., 12, 1904, 337) From milk.

Bacillus lactofoetidus Migula. (Bacil lus foetidus lactis Jensen, 22de Beretning fra den Kgl. Veterin og Landbohöjskoles Laboratorum for landöhonomiske Forsoeg, Copenhagen, 1891, 15; Migula, Syst. d. Bakt., 2, 1800, 740.) From tainted milk and butter.

Bacillus lanceolatus Mattes. (Sitzungsber d. Gesells z Beförderung d. gesam. Naturw. z. Marburg. 62, 1927, 381-417) From benign foulbrood of

bees (A pis mellifera).

Bacillus latticida Dyar. (Ann. N Y. Acad. Sci., 8, 1885, 377; Bacterium latticida Chester, Ann. Rept. Del. Col. Agr. Exp. Stn., 9, 1897, 103.) From the exudate of a diseased larva of a moth (Clisicampa fragilis).

Bacillus lassari Trevisan. (Bacillus des lichen ruber, Lassar, see Flügge, Die Mikroorganismen, 2 Aufl., 1886, 239; Trevisan, I generi e le specie delle Batteriacee, 1889, 14.) From lichen ruber, a skin disease.

Bacillus lentsformis Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1826, 418.) From the stomach and intestines of birds.

Bacillus leptinolarsae White. (Proc. Ent. Soc. Wash., 50, 1928, 71; Jour. Agr. Res., 51, 1935, 223.) From discused larvae of the Colorado potato-beetle (Leptinolarsa decemlinata).

Becillus levogi Trevisan. (Bacille de la diarrhée verte des enfants, Lesage, Bull. Acad. Méd., Paris, October, 1887; Trevisan, I generi e le specie delle Batteriacce, 1889, 14; Bacillus rirdis Kruse, i Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 292; Bacterium viridis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 8, 1897, 118.) Associated with green diarrhoea of children.

Bacillus limbatus Migula. (Bacillus limbatus butyri von Klecki, Cent. f. Bakt., 15, 1894, 359; Migula, Syst. d. Bakt., 2, 1900, 62.) From rancid lutter.

Bacillus limicola Russell. (Bot. Gaz., 18, 1893, 383.) From sea water and marine mud at Woods Hole, Massachusetts.

Bacillus lineatus Echstein. (2tschr. f. Forst- v. Jagdwesen, £6, 1691, 17)
From larvae of the nun moth (Lymantria monacha).

Bacillus lineatus Migula. (Bakterie V, Weigmann and Zirn, Cent. f. Bakt. 15, 1894, 467; Migula, Syst. d. Bakt., \$, 1900, 806; not Bacillus lineatus Eckstein, Zischr. f. Forst. und Jagdwesen, 29, 1894, 17.) From soapy milk.

Bacillus liparis Paillot. (Compt. rend. Acad Sci., Paris, 164, 1917, 527.) From larvac of the gypsy moth (Porthetria

(Lymantria) dispar).

Bacillus liquefaciens Doyen (Bacillus urinae liquefaciens Doyen, Jour. d. connaiss. médic., 1889, 183; Doyen, idem; not Bacillus liquefaciens Tiscoberg, Bakt. Diag., 3 Aufl, 1891, 112.) From urine.

Bacillus liquefaciens Migula. (Bacil-

lus suleatus liquefaciens Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 318, Migula, Syst d Bakt, 2, 1900, 723, not Bacillus liquefaciens Lisenberg, Bakt. Diag, 3 Aufl., 1891, 112 ) From water

Bacillus liquefaciens albus Vaughan (Amer, Jour Med Sci., 104, 1892, 185) From water

Bacillus Injudicions communis Stern berg (Sternberg, Man of Daet, 1893, 656); Bacterium liquefactens communis Chester, Ann Hept Del Col Agr Exp Sta, 9, 1897, 137.) From the feees of yellow fever patients Considered by Chester (loc cit, 91) to be synonymous with Bacillus aquatiles communes Kruse

Bacillus liquidus communis Sternberg (Manual of Bact, 1893, 686) From

feces
Bacillus litorosus Russell (Bot Gaz, 18, 1893, 414) From sea water and

marine mud at Woods Hole, Massachusetts

Bacillus loriacida Tartakowski
(Arch d Votennamies 1888 mieted

(Arch. d Veterinarwiss, 1888, quoted from Chester, Man Determ Bact, 1901, 211) Associated with an infectious disease of crossbills

Bacillus lucidus Migula (No 8, Lembke, Arch f Hyg, 26, 1896, 303, Migula, Syst d Bakt, 2, 1900, 674) From feces.

Bacillus lupi Trevisan (I generi e le specie delle Batteriacee, 1889, 12) From lupus, a skin disease

Bacillus lupim Migula (Bacillus tu berigenus 7, Gonnermann, Landwirtsch Jahrb, 23, 1894, 657; Migula, Syst d Bakt, 2, 1900, 793) From root nodules on lupine.

Bacillus Instigus Trevisan. (Bacillo moffensivo del Mytilus edulbs, Lustis, Arch per le sei med., 12, 1837, 17, Trevisan, see DeToni and Trevisan, Trevisan, See DeToni and Trevisan, 1839, 938; not Bacillus lustigus Carbone and Venturelli, Biol Ist. Sieroter., Milan, 4, 1925, 89) From the liver of a mussel (Mytitus edulus).

Bacillus luteo-albus Beijerinck.

(Botan Zeit., 46, 1888, 749.) From root nodules on legumes

Bacillus lutetiensis Chester. (Bacillus tiolaceus lutetiensis Kruse, in Tlugge, Die Mikroorganismen, 3 Auft., 2, 1896, 311, Chester, Man Determ. Bact., 1901, 306) From water.

Bacillus luteus Flügge (Die Mikroorganismen, 2 Auft, 1886, 209; not Bacitlus luteus von Dobrzyniecki, Cent f. Bakt, I Abt, 21, 1897, 835, not Bacillus luteus Garbowski, Cent f. Bakt, II Abt, 19, 1907, 641.) From air

Bacillus Iymantriae Picard and Blane. (Picard and Blane, Compt rend Acad Sci, Parus, 167, 1913, 80, Bacillus Iymantria a Paullot, 168, 1919, 268; Bacillus Ilmantria a Paullot, 168, 1919, 268; Bacillus (Bacterum) Iymantriae Paillot, L'infection chez les insectes, 1933, 131; Cecco-becillus Iymantriae Steinhaus, Catalogue of Bacteria Associated Extracellularly with Insects and Tecks, Minneapolis, 1912, 61 and 183) 1 From daeased larvae of the gypsy moth (Porthetria (Lymantria) dispar)

Bacillus lymantriae β Paillot. (Compt. rend Acad. Sci., Paris, 168, 1919, 258) From diseased larvae of the gypsy moth (Porthetria (Lymantria) dispar).

Bacillus lymantricola adiposus Paillot. (Compt. rend. Acad Sci., Paris, 188, 1819, 258; Becterum lymantricola adiposus Paillot, L'infection chez les insectes, 1933, 135) Trom caterpillars of Porthetra (Lymantria) dispar

Bacillus madidus Migula (No 5, Lembke, Arch. f. Hyg., 26, 1836, 300, Migula, Syst. d. Bakt., 2, 1900, 812) From bread.

Bacillus meggiorae DeToni and Trevisan (Bacillus B, Maggiora, Giorn Soc ital. d'Igene, 11, 1889, 310, DeToni and Trevisan, in Saccardo, Syllege Fungorum, 8, 1889, 063) From the skin of the human foot and from air.

Bacillus major Doyen (Bacillus urinae major Doyen, Jour d connaiss. médic., 1889, 107; Doyen, sbid, 108.) From urine.

Bacillus malariae Klebs and Tommasi-Crudeli. (Arch f. exper. Pathol., 2, 1879.) From swamp soil. See Sternberg, Man. of Bact., 1893, 523.

Barillus mammitidis Migula. (Bacillus a, Guillebeau, Ann. de Microg., 2, 1890, No 8; Migula, Syst. d. Bakt., 2, 1990, 810) From the milk of cows having mastitis.

Bacillus manganicus Beijerinck. (Folia Microbiol., Delft, 2, 1913, 130.) From soil. Motile. Is able to oxidize

manganese carbonate.

Bacillus margarincus Migula. (Diplococcus capsulatus margarincus Jolles and Winkler, Ztschr. f. Hyg., 20, 1895, 103, Mīgula, Syst d. Bakt., 2, 1900, 694.) From margarine.

Bacillus maricola Migula (Halibacterium polymorphum Fischer, Die Baktierien des Meeres, 1894, 36; Migula, Syst. d Bakt, 2, 1900, 709.) From sea water.

Bacillus marsiliensis Kruse. (Bacillus of Marseilles swine plague, Rietsch and Jobert, Compt. rend Acad Sci., Patts, 108, 1888, 1096, Kruse, in Flugge, Die Mikroorganismen, 3 Auft., 2, 1896, 405, Bacterium marsiliensis Chester, Ann Rept. Del Col Agr. Exp Sta., 9, 1897, 67) Associated with a disease of swine.

Bacillus martinez Sternberg (Sternberg, Man of Bact, 1893, 651, Bacillus martinezi Dyar, Ann N Y Acad. Sci, 8, 1835, 364, Bacterium martinezii Chester, Ann Rept. Del Col Agr Exp. Sta, 9, 1897, 83.) From the liver of a yellow fever cadaver. Dyar isolated an organism from the nir to which he applied Sternberg's name as the descriptions of the two species did not disagree

Bacillus melcagridis Migula (Mc-Fadycan, Jour Comp Path and Therap., 6, 1893, 334, Migula, Syst d Bakt, 2, 1900, 770, Bacillus melcagris Chester, Man Determ Bact, 1901, 220) The cause of epizootic pneumo-carditis in turkeys

Bacillus melleus Schroeter. (In Cohn, Kryptog Flora v Schlesien, 3, 1, 1885, 153) From feces and other sources

Bacillus melolonthae Chatton (Compt.

rend. Acad. Sci., Paris, 156, 1913, 1708.) From diseased cockehafers (Melolontha melolontha).

Bacillus melolonthae liquefaciens α, β and γ Paillot. (Compt. rend. Acad. Sci., Paris, 167, 1918, 1046; Annales des Épiphyties, 8, 1922, 108-110; B. melolonthae liquefaciens α, β and γ Paillot, L'infection chez les insectes, 1933, 173, 196 and 189 respectively. According to the index the B. is used for Bacterium) From discased cockchafers (Melolontha melolontha).

Bacillus melolonthae non-liquefaciens α, β and γ Paillot. (Compt. rend Acad. Sci., Paris, 163, 1916, 553; Annales des Épiphytics, 8, 1922, 111-113) From discased cockchafer (Melolontha melolontha).

Bacillus melolonthae non-liquefaciens & Paillot. (Compt. rend Acad Sci., Paris, 187, 1918, 1016; Annales des Épiphyties, &, 1922, 113.) From diseased cockchafers (Melolontha melolontha).

Bacillus melolonthae non-liquefaciens e Paillot. (Compt. rend. Acad. Sci., Paris, 169, 1919, 1122; Annales des Épiphyties, 8, 1922, 114.) From discased cockchafers (Melolontha melolontha).

Bacillus membranaceus Kern. (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 407.) From the stomach and intestines of a bird.

Bacillus meningitidis Migula (Bacillus aerogenes meningitidis Centami, Arch, per le scienze mediche, 17, 1833, No 1; Bacterium meningitidis aerogenes Chester, Ann Rept. Dol. Col. Agr Exp Sta, 9, 1897, 90, Migula, Syst. d Bakt, 2, 1900, 642; Bacillus radiatus Chester, Man. Determ Bact, 1901, 241.) From two cases of meningitis.

Bacillus metabolieus DeTon and Trevisan (Bacillus H, Maggiora, Giorn. Soc ital d'Igiene, II, 1889, 350; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 6, 1889, 968) From the skin of the human foot

Bacillus metoflavus Castellanı. (Proc. Soc. Expt. Biol and Med., 25, 1928, 539)
From the human skin.

Bacıllus minimus Eckstein (Ztschr Forst- u. Jagdwesen, 26, 1894, 16 ) From caterpillars of the nun moth (Lymantria monacha).

Bacillus minutissimus Migula

(Bacillus aureus minutissimus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 1896, 441; Migula, Syst d. Bakt. 2. 1900, 833 ) From air

Bacıllus mitidus Henrici (Arb bakt

Inst Karlsruhe, 1, Heft 1, 1894, 29) From Gouda cheese.

Bacillus mobilissimus Migula (Bacillus oogenes hudrosulfureus 8. Zorken dörfer, Arch f. Hyg., 16, 1893, 390, Migula, Syst. d. Bakt , 2, 1900, 791 ) From hens' eggs.

Bacillus mollis Doyen (Bacıllus urinae mollis Doyen, Jour d connaiss médic., 1889, 107; Doyen, 161d, 108) From urine

Bacillus morulans Boucquet (Phytopath, 7, 1917, 286 ) From diseased sugar beets Associated with curly top of sugar beet

Bacillus motte: Trevisan (Motte and Protopopoff, Wratsch , 1887, No 21, 415; abst in Cent f Bakt, 2, 1887, 450, Trevisan, I generi e le specie delle Batteriacee, 1889, 13 ) Associated with a rabies-like disease of rabbits and dogs

Bacillus (1) multiformis Castellani. (Proc Soc Exp. Biol and Med . 25, 1928. 539) From the human skin

Bazillus murinus Chester (Bazillus of rat plague, Issatschenko, Cent f Bakt , 23, 1899, 873; Chester, Man Determ Baet , 1901, 224, not Bueillus murinus Schroeter, in Cohn, Kijptog Flora v Schlessen, 3, 1886, 162) From the spicen and liver of rate attacked in St Petersburg by a plague

Bacillus mycogenes Edwards (Jour Inf Dis , 2, 1905, 431, Bacterium muco genum Edwards, idem ) From exudate of wound infections Belongs to the Bacillus mucosus capsulatus group

Bacillus mytili Trevisan (Bacillo pa togeno del Mytilus edulis, Lustig, Arch per le Sei med , 12, 1887, 17, Trevisan, see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 958) From the liver of a mussel (Mytilus edulis) Bacillus naphthalinicus liquefaciens Tausson (Planta, 4, 1927, 214) I'rom

oil-soaked soils at Baku, Russia dizes naphthalene.

Bacillus naphthalinicus non-liquefaciens Tausson, (Planta, 4, 1927, 214) From oil-soaked soils at Baku, Russia, Oxidizes naphthalene.

Bacıllus nebulosus Mıgula (Baçıllus tuberigenus 5, Gonnermann, Landwirtsch Jahrb , 23, 1894, 656, Migula, Syst d Bakt , 2, 1900, 844, not Bacillus nebulosus Wright, Mem Nat. Acad Sci., 7, 1894, 465, not Bacillus nebulosus Halle, Thèse de Paris, 1898; not Bacillus nebulosus Vincent, Ann. Inst Past , 21, 1907. 69. not Bacillus nebulosus Goresline, Jour Bact , 27, 1934, 52 ) From root nodules on lumine

Bacillus necans Trevisan, (Bacille consécutif au charbon, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 231, Trevisan, I generi e le specie delle Batteriacce, 1889, 14) From rabbits dead from anthrax.

Bacillus nephriticus Trevisan. (Bacille de la néphrite bactérienne, Babes, in Cornil and Babes, Les Bactéries, 2nd ed , 1886, 373, Trevisan, I generi e le specie delle Batteriacce, 1889, 14.) From urine in cases of nephritis

Bacillus neurotomae Paillot (Compt. rend Acad Sci , Paris, 178, 1924, 247; probably identical with Bacterium neurotomae Paillot, L'infection chez les insectes, 1933, 146 ) From diseased larvae of a sawfly (Neurotoma nemoralis L).

Bacillus nitens Migula (Bacıllus oogenes hydrosulfureus 1, Zörkendorfer, Arch f Hyg, 16, 1893, 390, Migula, Syst d Bakt , 2, 1900, 793 ) From hens' eggs

Bacillus ochroleucus Migula. (Bacillus oogenes hydrosulfureus e, Zörkendorfer, Arch f Hyg, 16, 1893, 387; Migula, Syst d Bakt, 2, 1900, \$11) From hens' eggs

Bacillus odoratus Weiss (Weiss, Arb bakt Inst Karlsruhe, 2, 1902, 213, not Bacillus odoratus Migula, Syst. d. Bakt., 2, 1900, 686; Bacterium odoratum Omeliansky, Jour. Bact., 8, 1923, 394.) From fermented beets.

Bacillus odorificans Migula. (Weisser stinkender Bacillus, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 711.) From water. Intense

odor resembling that of liquid manure.

Bacillus odorvicus Omchansky.

(Jour. Bact., 8, 1923, 393.) Probably

intended for Bacillus odorificans Migula.

Bacillus odorus Henrici. (Arb. bakt.
Inst. Karlsruhe, 1, Heft 1, 1894, 30.)
From cream cheese.

Bacillus conergasius Trevisan. (Bacille du mucus intestinal normal c, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 133; Trevisan, I generi e le specie delle Batteriacee, 1889, 15) From normal intestinal mucus.

Bacillus osteomyelitrcus Trevisan. (Bacille de l'ostéomyélite, Rodet; Trevisan, 1884; see Trevisan, I generi e le specie delle Batteriacee, 1889, 16) From a case of osteomyelitus.

Bacillus ozylacticus Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 369.) Culture received from Král's laboratory labeled Bacillus ozylacticus, also from air.

Bacillus pallescens Migula. (Bacillus luteus pallescens Losski, Inaug. Diss., Dorpat, 1893, 41, Migula, Syst. d. Bakt, 2, 1900, 819) From garden soil.

Bacillus pallidus Schroeter. (Schroeter, in Cohn, Kryptog Flora v. Schlesien, 5, 1, 1856, 153, not Bacillus pallidus Bredemann and Heigener, Cent f Bakt., II Abt, 93, 1935, 98.) From cocked potato

Bacillus panificans Laurent (Bull. Soc R. Bot Belg, 1885, 175) From

fermenting dough

Bacillus pannosus Kern (Arb. bakt Inst. Karlsruhe, 1, Heft 4, 1896, 409.) From the stomachs and intestines of

Bacillus pansini Migula (Bacillus No. 12, Pansini, Arch f. path. Anat, 122, 1890, 477; Migula, Syst. d. Bakt., 2, 1900, 600.) From sputum.

Bacillus parallelus Edson and Carpenter. (Vermont Agr. Exp. Sta. Bull. 167, 1912, 593.) From maple sap. Capsulated. At times Iecbly fluorescent.

Bacillus paullulus Trevisan. (Bacille de l'air d, Babes, in Cornil and Babes, Les Bactérics, 2nd ed., 1886, 149; Trevisan, I generi e le specie delle Batteriacce, 1889, 20.) From air.

Bacillus pectinophorae White and Noble. (Jour. Econ. Entomol., 29, 1936, 123) From diseased pink bollworm larvae (Pectinophora gossypiella).

Bacillus pediculi Arkwright and Bacot. (Parasitol, 13, 1921, 26) From the genital apparatus of the louse (Pediculus humanus).

Bacillus pellucidus Doyen (Bacillus urnae pellucidus Doyen, Jour. d. connaiss. médic., 1889, 107; Doyen, tbid., 108; not Bacillus pellucidus Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 404.) From urine.

Bacillus perlibratus Beijerinck. (Cent. f. Bakt., 14, 1893, 831) From a hean infusion.

Bacillus perroncus Trevisan. (Bacillo della pneumonite nodulare dei vitelini, Perroncito, Parassiti dell'uomo e dei animali utili, 1882, 52; Trevisan, I generi e le specie delle Batteriacce, 1889, 13.) From pulmonary nodules in contagious pneumonia in calves

Bacillus petersii Migula. (Baetruum B, Peters, Botan. Zeit., 47, 1889; Bacterium acudı lactici Kruse, in Flugge, Die Mikrootganismen, 3 Auft., 2, 1896, 357; not Bacterium acidı lactici Zopf, Die Spaltpilze, 2 Aufl., 1881, (0); not Bacterium acidı lactici I and II Grotenfell, Fortschi d Med., 7, 1899, 123; not Bacterium acidi lactici Migula, in Engler and Prantl, Die natürl. Pilanzenfam. 1, 1s., 1895, 25; Migula, Syst. d Bad., 2, 1900, 799.) From fermenting dough Probably Bacterium letars Wolffin.

Bacillus phenanthrenicus bal tensis Tausson (Planta, 5, 1928, 233.) From soil. Utilizes phenanthrene and other

Bacillus phenanthrenicus guricus Tausson. (Planta, 5, 1928, 239) From soil Utilizes phenanthrene and other hydrocarbons.

Bacillus phenologenes Berthelot (Ann. Inst. Past., 52, 1918, 20 i From feces Forms phenol

Bacillus pieris agilis Paillot (Compt rend. Acad. Sci., Paris, 168, 1919, 177) From diseased caterpillars of the cabbage butterfly (Pieris brassica)

Bacillus pieris fluorescens Paillot (Compt. rend Acad Sci., Paris, 168, 1919, 477; Ann. Epiphyt. 8, 1922, 124) 1919, 487; Ann. Epiphyt. 8, 1922, 124)

Hacillus pieris liquefaciers Paillot (Compt. rend Acad Sei , Paris, 168, 1919 1477; Bacillus pieris liquefaciers e Paillot, Annales des Epiphytics, 8, 1922, 125 ) From diseased enterpillars of the cabbage butterfly (Pieris brassicae) If this autority (Pieris brassicae) If this autority of the company of t

Bacillus pieris liquefaciens 8 Faillot (Annales des Épiphyties, 8, 1922, 126, name occurs as B. pieris liquefaciens 8 Paillot, L'infection chez les insectes, 1933, 29 According to the index B stands for Bacterium.) From diseased caterpillars of the cabbage butterfly (Pieris brassicae)

Bacillus pieris non liquefaciens a Pail lot. (Compt. rend. Acad Sci., Paris, 198, 1919, 477, B. pieris non-liquefacins a Paillot, L'infection cher les insectes, 1933, 135 ff. According to the index B stands for Bacterium.) From the cabbase butterfly (Pieris brassicae)

Bacellus piers non-lique/gactens β Pail lot. (Compt rend Acad. Sc., Pars. 168, 1919, 474; B piers non-lique/gacens β Paillot, L'infection ches les insectes, 1933, 299, according to the index, the B stands for Bacterium) From discased caterpillars of the cabbage butter-fly (Pieris brassicae).

Bacillus pleomorphus Migula. (Bacillus muritephteus pleomorphus Karliński, Cent. f. Bakt., 6, 1889, 193; Bacterium muristritcus pleomorphus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta. 9, 1897, 102, Migula, Syst. d. Bakt., 2, 1900, 649, Bacillus muritepticus Chester, Man Determ. Bact., 1001, 217; not Bacillus muritepticus Flügge, Die Mikroorganismen, 2 Aufl, 1886, 250) From Dus.

Bacillus plicatus Frankland and Frankland (Philos Trans. Roy Soc London, 178, B, 1888, 273, not Bacillus plicatus Zimmermann, see Frankland and Frankland, Microorganisms in Water, London, 1891, 459 ) From air.

Bacillus plumbeus Migula (Grau verilussigender Bacillus, Keck, Inaug. Diss, Dorpat, 1800, 51, Migula, Syst. d Bakt., 2, 1900, 719) From water

Bacillus pneumo-enterstidis murium Schilling (Arb a d kaiseil, Gesundheitsamte, 18. Heft 1, 1900) From a disease of rats

Bocallus preumosepticus Kruse. (Preumome bacillus, Klein, Cent. f. Bakt, 5, 1839, 625, Kruse, in Flogge, Die Mikroorganismen, 3 Auft, 2, 1830, 408, not Bacallus preumosepticus Babes, Progrès méd roumant, 6, 1859, Bacterium pneumosepticus Chester, Ann. Rept Del Cel Agr Exp Sta, 9, 1807, 76) From rusty sputum Considered the cause of an epidemic of pneumonia in England

Bacillus poels:: Chester (Vleeschvergiftung te Rotterdam, Poels and Dhont; Tweede Rapport van de des Kundigen, Chester, Man Determ. Bact., 1901, 209.) From beef in meat poisoning.

Bacillus pomodoriferus Castellani. (Proc. Soc Exp Biol and Med., 25, 1928, 540) From the urine in a case of

cystitis and from feces

Bacillus poncei Glaser. (Ann. Entomol Soc. Am, 11, 1918, 19) Pathorenie for the insects. Melanoplus femur-

rubrum and Encoptolopus sordidus.

Bacillus praepollens Maassen (Arb
a d. kaiserl. Gesundheitsamte, 15,

1899, 507.) From sweat of a cholera patient.

Boaillus primus fullesi Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 300; Bacterium primus fullesi Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 72.) From a leaf of the pitcher plant (Sarracenia purpurea). Regarded by Dyar as identical with Bacillus No 1, isolated by Fulles (Ztschr. I. Hyg., 10, 1891, 230) from forest soil.

Bacillus promissus Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 120.) From the intestines of a dove.

Bacillus proteidis Paillot. (Annales des Épiphyties, 8, 1922, 130) From discased larvae of the cabbage butterfly (Pieris brassicae).

Bacillus proterrus Trevisan (Bacillus der Conjunctivalsack d. Fick, Microorgan in Conjunctivalsack, Wiesbaden, 1887; Trevisan, I generi e le specie delle Batteriacec, 1889, 17) From the conjunctiva

Bacillus pruddeni Dyar (Ann. N. Y. Acad Sci., 8, 1895, 378.) Found by Dr. Prudden in a case of cystitis

Racillus pseudomirabilis Migula. (Bacillus mirabilis Tataroff, Inaug. Diss., Dorpat, 1831, 18, Migula, Syst. d Baht, 2, 1900, SIS) From water. According to Migula, Tataroff mistakenly believed that he had Zimmermann's Bacillus mirabilis

Bacillus pseudotuberculosis Migula. (Du Catal and Vaillard, Ann. Inst. Past., 5, 1891, 353, Bacillus pseudotuberculosis liquefacicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 455; Migula, Syst d Bakt., 2, 1990, 644) From nodules in the peritoneum

Bacillus pseudotyphosus Kruse. (Losener, Arb a d kauserl. Gesundheitsante, II, 1895, 2, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl, 2, 1896, 383; Bacterium pseudotyphosus Chester, Ann. Rept Del Col Agr Exp Sta, 9, 1897, 73, not Bacterium pseudotyphosum Migula, Syst d. Bakt, 2, 1900, 428 ) Isolated by Losener from peritoneal fluid of a hog, from water, etc.; by Pansim from a liver abscess; by Babes from a variety of sources. Kruse used this as a general name for any typhoid-like organism.

Bacillus pulpae pyogenes Miller. (Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1889, 219.) From gangrenous pulp of a tooth.

Bacillus punctatus Shul'gina and Kahnicker. (Rep. Bur. Appl. Ent. Leniagrad, 5, No. 1, 1927, 99-101, quoted from Steinhaus, Bact. Assoc. Extracell. with Insects and Ticks, Minneapolis, 1912, 79; not Bacillus punctatus Zimmermann, Bakt. unsecce Trink- u. Nutzwasser, Chemnitz, I Reine, 1800, 33.) From the locust (Locusta migratoria).

Bacillus puncticulatus Migula (No. 16, Lembke, Arch. f. Hyg., 29, 1897, 322; Migula, Syst. d. Bakt., 2, 1900, 678) From feces.

Bacillus putidus Kern. (Kern, Arb bakt. Inst. Karlsruhe, I, Ilett 4, 1896, 409, not Bacillus putidus Chester, Man. Determ. Bact., 1901, 237; not Bacillus putidus Weinberg et al., Les Microbes Anaérobies, 1937, 790.) From the stomach and intestines of birds.

Bacillus pylori Ford. (Studies from the Royal Victoria Hosp., Montreal, 1 (5), 1903, 44; also sec Jour. Med. Res., 1, 1901, 217.) From the stomach.

Bacillus pyogenes Lucet, (Bacillus pyogenes bovis Lucet, Ann. Inst. Past., 7, 1893, 372; Lucet, tbid., 328; not Bacillus pyogenes Glage, Zischr. f Fleish u. Milchhyg., 15, 1903, 166.) From bovice abscresses

Bacillus pyogenes var. liquefactus Chester. (Bacillus pyogenes foelidus liquefactens Lans, Cent f. Bakt, 14, 1893, 277; Bacterium pyogenes foetidus liquefactus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 92; Chester, Man. Determ. Bact , 1901, 235 ) From a brain abscess after otitis media.

Bacilius pyogenes soli Bolton. (Ann Jour Med Sci, June, 1892, quoted from Sternberg, Man of Bact., 1893, 728.) From garden earth.

Buellus pyrameis I and II, Paillot. (Compt. rend. Acad. Sci., Paris, 157,

1913, 611.) From tissues and blood of the caterpillar of Puramers (Vancesa) cardus. A coccobacillus.

Bacillus radians Trevisan (Bac térie de l'air No. 2, Babes, in Cornil and Babes, Les Bact/ries, 2nd ed . 1886, 140, Trevisan, I generi e le specie delle Batteriacce, 1889, 20.) From air.

Bacillus ramificans Migula (Bacillus No. 9, Pansini, Arch. f path Anat , 122, 1800, 445; Migula, Syst d Bakt . 2. 1900, 661; Bacillus pansini Chester, Man. Determ Bact., 1901, 216, not Bacillus pantinti Migula, loc cit, 660) From soutum.

Bacillus recupératus Wright (Wright, Mem. Nat. Acad Ses., 7, 1895, 439, Bac tersum recuperatus Chester, Ann Rent Del. Col Agr. Exp Sta. 9, 1897, 74.)

From Schuylkill River water

Bacillus repazii Herter (Bacıllus moliniformis Repazi, Compt rend Soc Biol , Paris, 68, 1910, 410; not Bacellus moniliformis Garnier, Arch. Méd expér ct Anat. pathol., 19, 1908, 785, Herter, in Just's Botan Jahresber , 39, 2 Abt , Heft 4, 1915, 750 ) From a lung abscess

Bacillus rhinitis atrophicans Paulsen (Paulsen, quoted from Chester, Ann Rept. Del, Col Agr. Exp Sta , 9, 1897, 79, Bacierium rhinitis atrophicans Chester, ibid., 141) From pasal secretions

Bacillus rigidus aras White Path. and Bact., 24, 1921, 70) From

intestine of bee.

Bacillus rogerii Migula (Bacıllus septicus putidus Roger, Revue de Méd , 1891, 10, Migula, Syst. d Bakt, 2, 1900, 647, Barterium septicus putidus Chester, Ann. Rept Del. Col Agr Exp Sta , 9, 1897, 92, Bacillus putidus Chester, Man Determ Bact , 1901, 237, not Bacillus putidus Kern, Arb bakt Inst Karlsruhe, 1, Heft 4, 1896, 400, not Bacillus putidus Weinberg et al , Les Microbes Anaérobies, 1937, 790) From the spinal fluid and liver in a case of cholera.

Bacillus rosaceus Migula. (Bacillus rosaceus margarinicus Jolles and Winkler, Ztschr. f. Hyg , 20, 1805, 105; Migula, Syst. d Bakt., 2, 1900, 859.) From margarine Red pigment.

Bacillus rosaceus metaloides Dyar. (Bacterium rosaccus metaloides Dowdeswell, Ann. de Micrographie, 1, 1888-89, 310, Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 376, not Bacillus resaccus metalloides Tataroff, Insug Diss. Dornat. 1891, 65, see Hefferan, Cent. f. Bakt., II Abt., 8, 1902, 689; Bacterium rosaceum Lehmann and Neumann, Bakt. Diag , 2 Aufl . 2, 1899, 261.) Culture from Dr. Crookshank, London.

Bacillus roscus Migula (Halshar. tertum roseum Fischer, Die Bakterien des Meeres, 1894, 22, Migula, Syst. d. Bakt , 2, 1900, 860, Bacillus roseus fischers Nepseux, Thèse, Fac. Pharm. Paris, 1920, 115 ) From sea water pigment

Bacillus rosenthalis Migula, (Rosenthal, Inaug Diss., Berlin, 1893, 37; Migula, Syst d. Bakt , 2, 1900, 656 ) From the oral cavity

Bacillus rubescens Edington (Ann. Rept Fish Board for Scotland, 6, 1887. 201) From reddened salted codfish

Bacillus rubescens Jordan Massachusetta State Board of Health, Boston, 1800, 835, Bacterium rubescens Chester, Ann Rept Del. Col. Agr. Exp. Sta , 9, 1897, 115 ) From sewage.

Bacillus rubiginosus Catiano. Cohn, Beitr z Biol d Pflanzen, 7, 1896, 538) From the vagina. Red picment.

Bactllus rubiformis Kern (Arb bakt Inst Karlsruhe, 1, Heft 4, 1896, 431 ) From the stomach of a bird

Bacillus rubrofuscus (Fischer) Migula (Halibacterium rubrofuscum Fischer, Die Bakterich des Mecres, 1894, 36, Migula, Syst d Bakt , 2, 1900, 865 ) From sea water.

Bacıllus rubus (sic) Chester rother Bacillus, Lustig, Diag d Bakt d. Wassers, 1893, 72, Bacillus ruber aquatilis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl . 2. 1896, 303, Bacterium ruber aquatilis Chester, Ann Rept Del. Col Agr. Exp Sta , 9, 1897, 112, Chester, Man. Determ. Bact., 1901, 257; Bacillus lustiga Chester, ibid., 301.) From water.

Bacillus salmoneus Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 361; Bacterium salmoneus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 116.) From air.

Bacillus salutarius Metchnikoff. (Metchnikoff. Aladies des hannetons du ble, Odessa (in Russian), quoted from Paillot, L'infection chez les insectes, Paris, 1933, 123.) From diseased lavyae of a heetle (Anisonlia nutrinea)

larvae of a beetle (Anisoplia austriaca).

Bacillus sanguineus Schroeter. (In
Cohn, Kryptog. Flora v. Schlesien, 3, 1,
1886, 196.) From stagnant water.

Bacillus saponaceus Miguia. (Bacillus lactis saponacei Weigman and Zirn, Cent. f. Bakt., 15, 1891, 464; Migula, Syst. d. Bakt., 2, 1900, 692.) From soapy milk.

Bacillus saprogenes Chester. (Bacillus saprogenes vini VI Kramer, Bakteriol. Landwirtsch., 1890, 139; Chester, Man. Determ Bact., 1901, 289.) From diseased wine.

Bacillus saprogenes Trovisan. (Bacillus saprogenes I, Rosenbach, Mikroorganismen bei den Wundinfectionskrankheiten des Menschen, Wiesbaden, 1881; Trovisan, I generi e le specie delle Batteriacee, 1889, 17, Bacterum saprogenes Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 142.) From fecces,

Bacıllus sarracentedus Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 357; Bacterium sorracentedus (sic) Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 81) From a fresh leaf of the pitcher plant (Sarracenta purpurca).

Bacillus scarlatinae Jamieson and Edington. (Jamieson and Edington, Brit. Med Jour, 1, 1887, 1265; Bacillus sudaminis Trevisan, I generi e le specie delle Batteriacce, 1889, 15) From the skin of scarlet fovor natients

Bacillus scoticus Migula (Bacillus der Grouse-discase, Klein, Cent. 1. Bakt., 6, 1889, 36 and 593; ibid, 7, 1890, 81; Migula, Syst. d Bakt, 2, 1900, 768; Bacillus tetraonis Chester, Man. Determ. Bact., 1901, 221.) The cause of a disease of grouse (Lagopus scoticus) in England and Scotland.

Bacillus secundus Trevisan (Bacillus II, Leube, Arch. f. path. Anat., 100, 1885, 000; Trevisan, I generi e le specie delle Batteriacee, 1889, 16.) From urine.

Bacillus secundus fullesi Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 359; Bacterium secundus fulessii (sic) Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807, 62; Bacterium secundus fulesi Chester, ibid., 143.) From air Dyar regarded his organism as identical with Bacillus No. 2 of Fulles (Ztschr. f. Hyg., 10, 1891, 250) which was from soil Bacillus septicaemiae lophyri Shiperovich. (Shiperovich, Protect. Plants Ukraine, 1925, 41–46; Abs. in Rev. Appl. Ent., A., 14, 1925, 200.) From larvae of sawlifes (Divrion settifer).

Bacillus septicamicus Trevisan (Bacillus of septicemia of man, Klein, Microorganisms and Disease, 1885, 81; Trevisan, in DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 945) From blood and infected lymph glands

Bacillus septicus homanis Mironofi, (Mironofi, Cent. f. Gynakol., 1872, 42; Bacterium septicus hominis Chester, Ann. Rept. Del. Col. Agr. Esp. Sta., 9, 1807, 143.) From a case of septic infection of the uterus. Regarded by Chester (Man Determ. Bact., 1901, 143) as a synonym of Pasteurella agrigena Trevisan.

Bacillus septicus resicae Clado. (Bullde la Soc. anatom. de Paris, 1887, 329) From the urine of a person suffering from cystitis

Bacillus sericcus Zimmermann (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 2, 1894, 52.) From water.

Bactllus serratus Migula. (Bacillus No. 14, Pansini, Arch f. path Anat, 122, 1890, 449; Migula, Syst. d. Bakt, 2, 1900, 658.) From sputum.

Bacillus setosus Migula (Bacillus No XVIII, Adametz, Landwirtsch. Jahrb, 18, 1889, 250; Migula, Syst. d. Bakt , 2, 1900, 812 ) From cheese.

Bacıllus suberschmidii Chester (Bacıllus der Fleischvergitlung, Sulberschmidt, Correspondenz-Blatt f Schweizer Aerzte, 1896, No 8; Chester, Man Determ. Bact , 1901, 212.) From poison 018 meat.

Bacillus simulans Trevisan (Bacille de l'arr a, Babes, in Cornil and Babes, Les Bactérics, 2nd ed., 1886, 149, Trevisan, I generi e le specie delle Batteriacee, 1889, 20 ) From air

Bacillus singularis Losski (Inaug Diss, Dorpat, 1893, 45) From garden soil.

Bacillus siliculosus Kern. (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 423) From the stomachs and intestines of birds.

Bacillus sordidus Dysar (Dysar, Ann N. Y. Acad Sci, 8, 1895, 379, Bacterium sordidus Chester, Ann Rept Del Col Agr. Exp. Sta., 9, 1897, 79) Culture received by Dysar as Micrococcus sordidus from Krill's laboratory

Bacillus sordidus Kern. (Arb Bakt Inst. Karlsruhe, 1, Heft 4, 1896, 396) From the stomach of a bird.

Bacillus spermophilinus Issatchenho (En aus Zieselmäusen ausgeschiedene Ban eillus, Mereschkousky, Cent f Bakt, 17, 1895, 742, Issatchenko, Scripta Botanica Hort Univ. Imp Petropolitanae, Fasc. XV, 1897, quoted from Migula, Syst. d. Bakt., 2, 1890, 618) Apparently resembled Salmonella upphamurum From ground squirrels (Spermophilus musicus)

Bacillus spirans Weiss (Arb bakt Inst. Karlsruhe, 2, Heft 3, 1902, 222) From bean infusions.

Bacillus spumosus Zimmermann (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, 2, 1891, 23) From water Bacillus spumosus Pansini (Arch

 path. Anat , 122, 1890, 448) From sputum.

Bacillus strassmanni Trevisan. (Bacillus albus cadqieris Strassmann and Strecker, Zischr f. Medicinalbeamte, 1883; Trevisan, I generi e le specie delle Batternacee, 1889, 17, Bacterium albus Cadaeris Chester, Ann. Rept Del Col. Agr. Erp Sta., 9, 1897, 102; Bacillus cadaeris Migula, Syst. d. Bakt., 2, 1900, 616) From the blood of an infant

Bacillus striatus Doyen (Bacillus urinae striatus Doyen, Jour. d connaiss. médic, 1889, 107, Doyen, ibid, 108) From urine.

Bacillus striatus albus von Besser. (Ziegler's Beitrige, 4, 1889, 331) Found in normal nasal mucus

Bacillus striatus flavus von Besser. (Ziegler's Beitrage, 4, 1889, 331; Bacterium striatus flavus Chester, Ann Rept. Del Col Agr. Exp Sta, 9, 1897, 111.) From nasal mucus. Rare.

Bacillus strumitidis Migula (Bacillus strumitis a, Tavel, Ueber die Actiologie der Strumitis, Basel, 1892, 81, Migula, Syst. d Bakt, 2, 1900, 741) From a case of strumitis

Bacillus strumitis Tavel. (Tavel, 1889, see Viquerat, Ann de Micrographie, 2, 1889-1890, 228) From acute catarrhal strumitis

Bacillus subcoccoideus Migula. (Bacillus aquatilis sulcatus III, Weichselbaum, Das osterreichische Samitatsnesen, 1889, No. 14-23, Migula, Syst d Bakt , 2, 1900, 732) From water

Bocallus subflavus Zimmermann. Zammermann, Bakt. unserer Trink u. Nutswasser, Chemnett, I, 1890, 62. Becterium subflavus Chester, Ann. Rept. Del Col Agr. Evp Sta., 9, 1897, 109.) From water According to Chester (Man Determ Bact, 1901, 2391), Beadlus flarescent Pohl is identical with this snecies

Bacillus subgastricus White (U. S. Dept Agr Bur Ent, Tech. Bul. 14, 1006, 23) From intestinal contents of honey bee (Apis mellifera). While this does not appear to be the same as Bacillus gastricus Ford (see Steinhaus, Breteris Associated Extracellularly with Insects and Ticks. Minneapolis, 1912, \$5), it may have been desembed by some

previous author as White does not indicate that he regards it as new.

Bacillus subochraceus Dyar. (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 358; Bacterium subochraceus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 0, 1897, 110.) From air.

Bacillus subrubiginosus Migula. (Braunroter Bacillus, Maschek, Bakt. Untersuch d. Leitmeritzer Trinkwasser, Leitmeritz, 1887, Migula, Syst. d. Bakt., 2, 1900, 836.) From water.

Bacillus subsulcatus Migula. (Bacillus aquatilis sulcatus II, Weichselbaum, Das österreichische Sanitatswesen, 1889, No. 14-23; Migula, Syst. d. Bakt., 2, 1900, 732.) From water

Bacillus sulcatus Chester. (Bacillus sulcatus Iquefaciens Kruse, in Flügge, Die Mikroorgannsmen, 3 Aufl. 2, 1596, 318; Bacterium sulcatus liquefaciens Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 97; Chester, Man. Determ. Bact, 1901, 213; not Bacillus sulcatus Migula, Syst. d. Bakt, 2, 1900, 731.) From water.

Bacillus sulcatus Migula (Bacillus aquatitis sulcatus I, Weichselbaum, Das österreichische Sanithtswesen, 1889, No. 14-23; Migula, Syst d Bakt, 2, 1900, 731.) From water

Bacillus sulfhydrogenus Miquel. (Ann. de Micrographie, 1, 1888-1889, 369) From sewage.

Bacillus tardissimus DeToni and Trevisan (Bacillus fluidificans tardissimus Maggiora, Giorn Soc ital. d'Igene, 11, 1889, 317, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 967) From the shin of the human foot

Bacillus fartricus Grimbert and Fiquet. (Jour. Pharm. et de Chim, 6° Scr., 7, 1898, 97; Compt rend. Soc. Biol, 49, 1897, 962) Decomposes d-tartrates. Probably identical with Aerobacter cloacae (Vaughn et al., Jour. Bact, 52, 1946, 324).

Bacillus telmatis Trevisan (Bacillus saprogenes 2, Rosenbach, Mikroorganismen bei den Vundinfectionskrankheiten des Menschen, Wiesbaden, 1884; Trevisan, I generi e le specie delle Batteriacee, 1889, 14) From perspiration of feet.

Bacillus tenuis Doyen. (Bacillus urnae tenuis Doyen, Jour. d. connaiss. noddie., 1889, 107; Doyen, ibid. 108; not Bacillus tenuis Migula, Syst. d. Bakt., 2, 1900, 587; Bacillus tenuatus Trevisan, in DeToni and Trevisan, in DeToni and Trevisan, from urine.

Bacillus tenus apis White. (Jour. Path. and Bact., 24, 1921, 72.) From intesting of bee.

Bacillus terrigenus Frank. (Berichte deutsch. botan. Gesellsch., 4, 1886, 000.) From soil.

Bacillus thermophilus Miquel. (Miquel, Ann. de Microge., J., 1885-1889, 6; not Bacillus thermophilus Chester, Man. Determ. Bact., 1901, 265; not Bacillus thermophilus Bergey et al , Manual, 1st ed., 1923, 315.) From water, sewage, soil, etc.

Bacillus theta Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 375; Bacterium theta Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 144.) From air.

Bacillus tingens Eckstein. (Ztschr. f. Forst-u. Jagdwesen, 26, 1894, 10.) From dead larvae of Orgyia pudibunda.

Bacillus toluolicum Tausson. (Planta, 7, 1929, 735.) From soil. Oxidizes toluene.

Bacillus torigenus Chester. (Bacillus of 1ce eream poisoning, Vaughn and Perkins, Arch. f. Hyg., 27, 1896, 308; Chester, Man. Determ. Bact., 1901, 208) From poisonous ice cream

Bacillus trambustii Kruse. (Trambusti and Galeotti, Cent. f. Bakt., 11, 1892, 717; Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 319; Bacterium trambusti Chester, Ann Rept. Del. Col Agr. Exp. Sta., 9, 1897, 97.)
From water.

Bacillus tremaergasius Trevisan. (Bacille du mueus intestinal normal d, Babes, in Cornil and Babes, Lee Bactérics, 2nd ed., 1886, 153; Trevisan, I generi e le specie delle Batteriace, 1850, 16) From normal intestinal mueus Bacıllus trimethylamin Beijerinck. (Bot. Zeitung, 46, 1888, 726.)

Bacillus truttae Mersch (Quoted from Lehmann and Neumann, Bakt Diag., 7 Aufl., 2, 1927, 481.) Closely related to Bacterium salmonicida Lehmann and Neumann

Bacillus tumidus Chester. (Anaerobe Bacillus I, Sanfelice, Ztschr. f Hyg., 14, 1893, 265; Chester, Man Determ Bact, 1901, 265.) From putrefying flesh Strict anaerobe.

Bacillus ufreduzzii Trevisan (Batteno della setticemia salivare nei conigli, Bordoni-Uffreduzzi and Di-Mattei, Arch per le secienze med 10, 1886, Trevisan, see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1880, 951) From normal human saliva.

Bacillus ulna Cohn (Beitr z Biol d. Pflanz., 1, Heft 2, 1872, 177) From water, air, etc.

Mater, air, etc.

Bacillus umbilicatus Zimmermann
(Bakt. unserer Trink- u Nutzwasser.
Chemnitz, 2, 1894, 6) From water

Bacillus urinae Migula. (Ein Harnbacterium, Karplus, Arch f path. Anat . 131, 1803, 211; Migula, Syst d. Bakt , 2, 1900, 739.) From urine

Bacillus utpadeli Trevisan. (Bacillus aus Zwischendeckenfüllung, Utpadel, Arch. f. Hyg., 6, 1857, 359, Trevisan, I generi e le specie delle Batteriacee, 1889, 15.) From the intestine

Bacilius vacuolatus Dyar (Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 367. Bacterium tacuolatus Chester, Ann Rept Del. Col Agr. Exp Sta., 9, 1897, 81 From a trap of the carnivorous water plant, Utricularia vuloura

Bacillus tegetus Kern (Arb bakt Inst. Karlsrube, 1, Heft 4, 1896, 399) From the stomach and intestines of birds.

Bacillus relox Kern (Arb bakt Inst Karlsruhe, 1, Heft 4, 1996, 405) From the stomach and intestines of birds

Bacillus venenosus brevis Vaughan (Amet. Jour. Med. Sci., 104, 1892, 192; Bacterium renenosus and Bacterium renenosus brevis Chester, Ann. Rept. Del. Col Agr. Exp. Sta., 9, 1897, 76) From water.

Bacillus senenosus Chester. (Bacillus venenosus imissibilis Vaugham, Amer. Jour Med. Set., 104, 1892, 192, Bacterium senenosus imissibilis Chester, Ann Rept Del Col Agr Eap Sta., 9, 1897, 76, Chester, Man Determ Bact, 1901, 224, not Bacillus senenosus Vaugham, Amer. Jour Med Sci., 104, 1892, 191.) From water

Bacillus venenosus liquefaciens Vaughan (Amer. Jour Med. Sci., 104, 1892, 193) From water.

Bacilius ventricosus Weiss (Weiss, Arb bakt. Inst Karlsruhe, g. Heft 3, 1902, 233, not Bacilius ventricosus Bredemann and Heigener, Cent 1 Bakt., II Abt., 93, 1935, 102) From vegetable infusions

Bacillus ventriculi Raczynski (Diss. milit. medic Acad Petropolitanae Ruteniae, 1888, abst in Cent f Bakt, 6, 1889, 113) From the stomach of a dog

Bacillus termiculosus Zimmermann (Zimmermann, Bakt unserer Trink- u Nutzwasser, Chemnitz, 1, 1890, 40, Bacterium vermiculosus Chester, Ann Rept Del Col Agr Exp Sia, 9, 1807, 99) From water

Bacillus versatilis DeToni and Trevisan (Bacillus A, Maggiora, Giorn Soc ital d'Igiene, II, 1889, 339, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 968) I Prom the skin of the human foot and from air

Bacillus resiculiferus Migula (Bacillus strumits \$, Tavel, Ueber die Aetiologie der Strumits, 1892, 110, Migula, Syst d Bakt, 2, 1900, 741) From a case of strumits

Bacillus vialis Hansgirg (Oesterr, bot Ztschr, 1888, 6) From roadside soil from near Prague

Bacillus viator Trevisan (Bacille de l'air c, Babes, in Cornil and Babes, Les Bactéries, 2nd ed., 1886, 150, Trevisan, I generi e le specie delle Batteriacce, 1889, 20) From air

Bacillus villosus Migula. (Bacillus aqualilis villosus Tataroff, Inaug. Diss.,

Dorpat, 1891, 47; Migula, Syst. d. Bakt., 2, 1900, 828; not Bacillus villosus Keek, Inaug. Diss., Dorpat, 1890, 47.) From water.

Bacillus vinicola Migula. (Bacillus saprogenes vini II, Kramer, Die Bakterien in ihren Beziehungen zur Landwirtschaft, 2, 1892, 136; Migula, Syst. d. Bakt., 2, 1900, 085.) From wine.

Bacillus viniperda Migula. (Bacillus saprogenes vini I, Kramer, Die Bakterien in ihren Beziehungen zur Landwirtschaft, 2, 1892, 135; Migula, Syst. d. Bakt., 2, 1900, 084) From wine.

Bacillus virens van Tieghem. (Bull. Sec. bot. France, 27, 1880, 175.) From aquatic plants.

Bacillus viridans Zimmermann. (Bakt. unserer Trink. u. Nutzwässer, Chemnitz, 2, 1894, 22.) From water.

Bacillus viridescens non-liquefactens Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1896), 14; Bacterium virdescens non-liquefactens Chester, Ann. Rept. Del. Col. Agr. Lxp. Sta., 9, 1897, 72 and 123.) Irom soil.

Bacillus vulpinus von Iterson. (Cent. f. Bakt., II Abt., 12, 1904, 111.) From fresh garden soil, canal water.

Bacillus wardit Chester. (Gas- and taint-producing bacillus in cheese curd, Moore and Ward, Cornell Univ. Agr. Expt. Sta, Bull. 158, 1899, 221-227, Chester, Man, Determ Bact., 1901, 206.) From tainted, gassy cheese curd and from milk drawn directly from the udder Presumably this was a coliform organism

Bacillus weckers Trevisan (Bacillus der Jequirity-Ophthalmie, de Wecker, 1882; see Flüge, Die Mikroorganismen, 2 Ausl., 1886, 279, Trevisan, 1 generi e le specie delle Batteriacce, 1889, 17.) From infusions of jequirity seed (Abri precadorti)

Bacillus wesenbergii Chester (Bacillus der Fleisehvergiftung, Wesenberg, Ztschr. f. Hyg., 28, 1895, 484; Chester, Man Determ. Bact., 1901, 247; not Bacillus wesenberg Castellani.) From meat which caused a meat poisoning outbreak. Closely related to Proteus rulgaris Hauser.

Bacillus trichmanni Trevisan. (Goldgelber Wasserbacillus, Adametz and Wichmann, Mitth. Ost. Vers. Stat. f. Brauerei u. Milz., 1, 1883, 49; Trevisan, I generi e le specie delle Batteriacee, 1889, 19; Bacillus chryseus Migula, Syst. d. Bakt., £, 1900, 833.) From water.

Bacilluszeta Dyar. (Dyar, Ann. N. Y Acad. Sci., 8, 1895, 369; Bacterium zeta Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 114.) From air.

Bacillus zonatus Migula. (Bacillus No. 15, Pansini, Arch. f. path. Anat, 122, 1890, 450; Migula, Syst. d. Bakt, 2, 1900, 658.) From soutum.

Bacillus zörkendörferi Migula. (Bacillus oogenes hydrosulfureus γ, Zörkendörfer, Arch. f. Hyg., 16, 1893, 385; Migula, Syst. d. Bakt., 2, 1900, 696.) From hens' egge.

Ractilus zymoseus (Leube) Trevisan (Coccobacillus zymogenes Leube, Arch. f. path. Anat., 1885; Trevisan, I generi e le specie delle Batteriacee, 1889, 16) From fermenting infusions.

Bacterium acidi propionie: Weigmann (Weigmann, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76; Plocamobacterium acidi propionici Pribram, idem.)

Bacterium aeris Migula. (Bacillus activis minutasimus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1895, 441; Bacterium aeris minutissimus Chester, Ann. Rept. Del. Col. Agr Eap. Sta., 9, 1897, 109, Migula, Syst. d. Bakt., 2, 1900, 445, Bacterium aeris-minutissimum Chester, Man Determ. Bact., 1901, 168.) From air.

Baclerium aerogenes I and II Miller. (Miller, Deutsche med. Wochnschr., 12, 1886, 119; see Miller, Die Mikroorganismen der Mundhohle, Leipzig, 1889, 261

and Trevisan, in Saccardo, bylinge Fungorum, 8, 1889, 952.) From the digestive tract of man Bacterium agreste Lohnis (Löhnis, Cent f. Bakt., I Abt., Orig , 40, 1906, 177; Bacillus agrestis de Rossi, Microbiol agraria e technica, Torino, 1927, 828, not Bacillus agrestis Werner, Cent. f Bakt., II Abt., 87, 1933, 468) From soil

Bacterium agrigenum (Trevisan) Migula. (Bacillus septicus agrigenus Flügge, Die Mikroorganismen, 2 Auf, 1886, 257; Pasteurella agrigena Trevisan, I genori e le specie delle Batternace, 1889, 21; Bacterium septicus agrigenus Cliester, Ann. Rept. Del Col Agr Exp Sta, 9, 1897, 85; Migula, Syst d Bakt, 2, 1900, 372; Bacterium septicum Chester, Man. Determ Bact. 1901, 143) From Man. Determ Bact. 1901, 143) From

soil.

Bacilius, Tataroff, Inaug. Diss , Dorpat, 1891, 35; Migula, Syst d Bakt , £, 1900, 419 ) From water.

Bacterium algeriense Migula (Gayon and Dubourg, Ann Inst Past, 8, 1894, 108, Migula, Syst d. Bakt, 2, 1900, 513) Isolated in Algiers from wine where it causes a manuful fermentation

Bacterium aliphaticum Tausz and Peter. (Cent. f. Bakt, II Abt, 49, 1919, 505) From garden soil

Bacterium aliphaticum liquefaciens Tausz and Peter. (Cent f Bakt, II Abt., 49, 1919, 505.) From garden soil

Auc., 49, 1819, 303.) From garden as Ractersum allantoides (Klein) Chester (Bacillus allantoides Klein, Cent f Bakt., 6, 1889, 383, Chester, Ann Rept Del. Col. Agr Exp Sta. 9, 1897, 103 ) Isolated as a culture contamination

Bacterium alutaceum Migula (Goldgelber chagrinierter Bacillus, Tataroff, Inaug, Diss., Dorprt, 1891, 62, Migula, Syst. d. Bakt., 2, 1900, 461) From water.

Bacterium ambiguum Chester (Chester, Ann. Rept Del. Col. Agr. Exp. Sta. 11, 1900, 59, not Bacterium ambiguus Chester, ibid. 9, 1897, 71, not Bacterium ambiguum Levine, Abst. Bret. 4, 1920, 15) From Soil.

Bacterium amforeti Issatchenko (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian), Petrograd, 1914, 237.) From sea water.

Bacterium anaerobium Migula. (Fuchs, Inaug. Diss., Greifswald, 1890, Migula, Syst. d Bakt., 2, 1900, 388.) Obligate anaerobe. Pyogenic Possibly a spore-former

Bacterum anguillarum (Canestrini) Migula (Bacillus anguillarum Canestrini, Att d R Instituto Veneto di Scienze, Ser 7, 1892-93, Migula, Syst. d Bakt, 2, 1900, 442) From discussed cels in the valleys of Comacchio

Bacterium angustum Migula (Lembke, Arch f. Hyg, 25, 1896, 305, Migula, Syst d Bakt 2, 1900, 474) From frees

Bacterum aphlosum (Kruse) Chester. (Bacillus der Mundseuche des Menschen, Siegel, Deutsch med Wochnschr, 1891, No. 49, 1328, Bacillus aphlosus Kruse, in Flugge, De Mikroorganismen, 3 Auf. 2, 1896, 427, Chester, Ann Rept Del Col Agr Evp Sta. 9, 1897, \$5) From the liver and ladness of cattle affected with foot and mouth disease.

Bacterium apis No. 1, No. 2 and No. 3, Metalnikov and Kostriteky (Comptered Soc Biol., Paris, 114, 1933, 1291.) From diseased bees (Apis mellifera)

Bacterium aquatile aurantiacum von Rigler (Hyg Rund, 12, 1902, 40) From bottled mineral waters

Bactersum aquatile citreum von Rigler. (Hyg Rund., 12, 1902, 481) From bottled mineral waters.

Bacterium aquatile debile von Rigler. (Hyg. Rund , 12, 1902, 481) From bottled mineral waters

Bacterium aquatile flatum von Rigler. (Hyg Rund, 12, 1902, 480.) From bottled mineral waters

Bacterium aquatile luteum von Rigler. (Hyg. Rund, 12, 1902, 450.) From bottled mineral waters

Racterium arborescens non liquifaciens von Righer (Hyg Rund, 18, 1902, 479, not Bacterium arboresens non-liquifaciens Chester, Ann Rept. Del. Col. Agr. Evp. Sta., 9, 1907, 103) From battled mineral waters.

Bacterium arcticum Issatchenko. (Re-

cherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 148.) From sea water.

Bacterium arthritidis Migula. (Schüller, Berliner klm. Wochnschr., 1893, No. 36; Bacillus arthritidis chronicae Kruse, in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 287; Migula, Syst. d. Bakt., 2, 1900, 443.) From a case of chronic arthritis.

Bacterium asportferum Migula. (Flugge, Zischr. f. Hyg., 17, 1894, 290). Anaērobier No. II, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1890, 251; Migula, Syst. d. Bakt., 2, 1900, 446.) From milk.

Bacterium aurantii (Viron) Migula. (Bactilus aurantii Viron, Compt. rend. Acad. Sci., Paris, 114, 1892, 179, Migula, Syst. d. Bakt., 2, 1900, 512.)

Bacterium aurantium-roseum Honing (Honing, Cent f. Bakt., II Abt., 37, 1913, 373; Plocamobacterium aurantium Pribram, Klassifikation der Schizomyeeten, Leipzig und Wien, 1933, 77.) From fermenting tobacco.

Bacterium aurescens (Frankland and Frankland) Migula. (Bactilus aurescens Frankland and Frankland, Philos. Trans. Royal Soc of London, 178, 1887, B, 271; not Bactilus aurescens Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 8, Migula, Syst. d. Bakt., 2, 1900, 466) From air

Bacterium aureum (Frankland and Frankland) Migula. (Bactinus aureus Frankland and Frankland, Philos Trans. Royal Soc. of London, 178, 1887, B, 272; Migula, Syst. d. Bakt, 2, 1900, 480.) From air.

Bacterium aureum (Adametz) Chester. (Bacillus aureus Adametz, quoted from Sternberg, Man of Bact, 1893, 621, not Bacillus aureus Frankland and Frankland, Philos Trans. Roy. Soc. London, 178, 1857, B, 272, not Bacillus aureus Pansini, Arch. f. path. Anat., 122, 1890, 336; Bacillus aureo-flavus Kruse, in I'lugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 310; Bacterium aureo flavus Chester, 9, 1897, 109; Chester, ibid., 129; not Bac-

terium aureum Migula, Syst. d. Bakt., 2, 1900, 480; Bacilius flavus Chester, Man, Determ. Back., 1901, 255; not Bacilius flavus Fuhrmann, Cent. f. Bakt., 11 Abt., 16, 1907, 117; not Bacilius flavus Fuhrmann, Cent. f. Bakt., 11 Abt., 16, 1907, 117; not Bacilius flavus Bergey et al., Manual, 1st ed., 1932, 286.) From water (Adametz); from the skin in cases of exzema (Tommasoli, Monats. f. prakt. Dermatol., 9).

Bacterium arium Chester. (Bacillus of roup in fowls, Moore, U. S. Dept. Agr. Bur. Animal Industry, Bull. 8, 1895; Chester, Man. Determ. Back., 1901, 133) From exudate of fowls in roup or diphtheria.

Bacterium babesii Migula. (Bacillus zepticus acuminatus Babes, Bakteriologische Untersuchungen der septischen Prozesse des Kindesalters, Leipzig, 1880; see Eisenberg, Bakt. Diag., 3 Aufl., 1891. 237; Bacterium septicus acuminatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 66; Migula, Syst. d. Bakt., 2, 1900, 507; Bacterium acuminatus Chester, Man. Determ. Bact., 1901, 119.) From blood and organs of a new-born infant with septicemia.

Bacterium balbianii Billet. (Bullet, Compt. rend. Acad. Sci., Paris, 107, 1883, 425; also in Bull. Sci. de la France et de la Belgique, 21, 1890, 108; Bacillus balbianii Trevisan, I generi e le specie delle Batteriacee, 1889, 17.) From sea water.

Bacterium barentsianum Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 155.) From sea water.

Bacterium berjerinchi Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 157.) From sea water.

Bacterium benzoli a and b Wagner. (Ztsehr. f. Garungphysiol., 4, 1914, 289.) From soil. Utilize benzene and certain benzene derivatives.

Bacterium besseri Migula. (Besser, Cent f Bakt., 18, 1893, 590; Migula, Syst. d. Bakt, 2, 1900, 503.) From smallpox.

Bacterium betae viscosum Panek. (Bull. Acad. Sci. Cracovie, 1, 1905, 5.) From fermenting beets Reported to liquefy agar-gelatin (Biernacki, Cent f Bakt., 29, 1911, 166) Stanier (Jour Bact., 42, 1941, 548) thinks this was a heterofermentative Lactobacillus

Bactersum bossonis Chester (Bacillus uber eine neue Infektionskrank des Rundviehs, Bosso, Cent f. Bakt, 22, 1897, 537 and 23, 1898, 318, Chester, Man Determ. Bact, 1901, 153) Associated with an infectious disease of eatile

Bacterium boutrouzit (Trevisan) De-Toni and Trevisan. (Bicrococcus capable d'acétifier l'alcohol, Boutroux, Ann. Inst Past., 2, 1888, 209, Bacillus boutrouzi: Trevisan, I generi e le specie delle Batternace, 1889, 16, De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1021) From alcoholic infusions.

Beaterium borss Migula (Pneumobeatilus liquelacens bouts Arlong, Compt rend. Acad. Sci., Parss, 29, 18—, 109 and 116. Beatilus pneumoneus liquelacens Kruse, in Fluge, Die Mikroorganismen, 3 Aufl., 2, 1986, 288, Bacterium pneumonicus liquelacens Chester, Ann Rept Del. Col. Agr Evp Sta. 9, 1887, 29, Migula, Syst. d Bakt., 2, 1900, 442, Bacterium pneumonicum Chester, Man Determ. Bact., 1901, 183) From the evudate of lung plague in cattle A Grampositive encewshile bacterium

Bacterum brassicae Conrad (Bacterum brassicae acidae Lehmann and Conrad, in Lehmann and Neumann, Bakt. Diag, 1 Aufl, 2, 1896, 232, Conrad, Arch f. Hyg, 29, 1897, 82, not Bacterium brassicae Wehmer, Cent f Bakt., II Abt., 10, 1903, 628, not Bacterium brassicae Migula, Syst d Pakt, 7, 1900, 296 (Bacillus brassicae Pommer, Mitt. botan. Inst. Graz, 1, 1896, 93), Bacillus brassicae Migula, loc ett, 737 ) From sauerkraut.

Bacterium breitfussi Issatchenko (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 152) From sea water

Baeterium brevissimum Weiss. (Arb

bakt Inst. Karlsruhe, 2, Heft 3, 1902, 227.) From veretable infusions

Bacterium brunneostarum (Dyar) Chester (Bacilius brunneostarus Dyar, Ann. N. Y. Acad. Sci. 8, 1895, 362; Chester, Ann Rept. Del Col. Agr. Evp. Sta. 9, 1897, 112) Culture received from Kralt's laboratory as Micrococcus brunneus

Bactersum bullosum Migula. (Bacillus No 18, Pansını, Arch. f pathol Anat. u. Physiol., 122, 1890, 451, Migula, Syst. d Bakt, 2, 1900, 415) From feces.

Bacterium cadateris (Sternberg) Chester (Bacilius cadateris Sternberg, Man, of Bact, 1893, 492, Chester, Ann. Rept, Del Col Agr. Exp Sta, 9, 1897, 120) From liver and kidneys of yellow fever cadavers. Anaerobe

Bocterum canalis Migula (Kapseltragender Kanalbaeillus, Mon, Zischr f Hyg., 4, 1888, 52, Bacillus canalis capsulatus Sternberg, Man of Bact., 1933, 476, Bacterum canalis capvulatus Ches ter, Ann Rept Del Col Agr Lyp Sta, 9, 1897, 130, Migula, Syst d. Bakt., 2, 1900, 351) From sewage

Bacterium canalis parium (Sternberg) Chester (Bacillus canalis parius Sternberg, Man of Bact, 1893, 476, Chester, Ann. Rept Del Col Agr Lyp Sta., 9, 1897, 130) Obtained by Mori (1888) from sewage

Bacterum corneum (Kruse) Chester. (Flesschfarbger Bacillus, Tils, Zitehr. f. Hyg., 9, 1800, 291, Bacillus conneclor Frankland and Frankland, Microorganisms of Water, 1891, 477; Bacillus carneus Kruse, in Flügge, Die Mikroorganismen 3, Mulf., 2, 1805, 301, Chester, Ann Rept Del Col Agr Ivp Sta., 9, 1807, 113) From water

Bacterium carnosum Kern. (Arb. bakt Inst Karlsrube, 1, Heft 4, 1896, 448) From the intestines of birds.

Bacterum cartilogueum (Olsen-Sopp) Bachanan and Hammer (Bacullus cortilogueus Olsen-Sopp, Cent f. Bakt, II Abt, 55, 1912, 49, Buchanan and Hammer, Iowa Sta Agr Exp. Sta., Res Bull 22, 1915, 271) From slimy or ropy sour milk called falso tastic

Bacterium caseicola Migula. (Bacillus No. XII, Adametz, Landw. Jahrb., 18, 1889, 215; Migula, Syst. d. Bakt., 2, 1900, 475.) From cheese.

Bacterium castellum Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 38.) From cheese.

Bactersum catenula Dujardin. (Dujardin, Hist. natur. des zooph., 1811; Bacillus catenula Trevisan, I generi e le specie delle Batteriacee, 1859, 18; not Bacillus calenula Migula, Syst. d. Bakt ... 2. 1900, 588.) From rice paddies and swamps.

Bacterium caratum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 449.) I'rom the intestines of birds.

Bacterium carernae Migula, (Bacillus cavernae minutissimus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 410; Pfeiffer und Beck, Deutsch. med. Wochnschr., 1892, No. 21; Migula, Syst. d. Bakt., 2, 1900, 509.) From human tuberculosis.

Bacterium caviae fortuitum (Sternberg) (Bacillus carrae fortuitus Sternberg, Man. of Bact., 1893, 650; Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 74) From the liver of a vellow fever cadaver.

Bacterium cavicida haraniensis (Sternberg) Chester. (Bacillus cavicida havaniensis Sternberg, Man of Bact , 1893, 425; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 74.) From the intestine of a vellow fever cadaver.

Bacterium centrieum Migula Armin, Arch f. pathol, Anat u. Physiol, 134, 1893, 216; Migula, Syst d Bakt., 2, 1900, 390; not Bacterium concentricum, a typographical error, see Migula, abid . page v.) From a case of cystitis.

Bacterium cerinum Henrici bakt. Inst. Karlsruhe, 1, Heft 1, 1891, From cheese.

chlorinum Bacterium

Engelmann (Bot. Zeitung, 1882, 324.) Green pig-

Bacterium chologenes (Kruse) Chester (Colonbacillus, Stern, Deutsche med. Wochnschr., 1893, 613; Bacıllus chologenes Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1893, 374; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 69.) From a case of purulent meningitis.

Bacterium chryscum Migula. (Bacillus nova species II, Freund, Inaug. Diss., Erlangen, 1893, 37; Migula, Syst. d. Bakt., 2, 1900, 477.) Chromogenic bacterium from the mouth cavity,

Bacterium chrysogloea Zopf. (Zopf, in Overbeck, Nova Acta d. kais, Leop,-Carol. Akad. d. Naturf., 55, 1891, No. 7; Bacillus chrysogloia (sic) Zimmermann, Bakt, unserer Trink- u. Nutzwässer, 2, 1891, 12.) From water.

Bacterium citrcum (Frankland and Frankland) Migula, (Bacillus citreus Frankland and Frankland, Philos, Trans. Royal Soc. of London, 178, 1887, B, 272; Migula, Syst. d. Bakt., 2, 1900, 459.) From air.

Bacterium coli apium Serbinow. (Jour. Microbiol. Petrograd., 2, 1915, 19.) From honey bees (Apis mellifera)

Bacterium coli similis (Sternberg) Chester. (Bacillus coli similis Sternberg, Man, of Bact., 1893, 650; Chester, Ann. Rept. Del. Col. Agr. Exp Sta , 9, 1897, 132.) From a human liver.

Bacterium colloideum Migula. (Bacterium butyri colloideum Lafar, Arch. f. Hyg , 15, 1891, 17; Migula, Syst. d. Bakt , 2, 1900, 409.) From butter.

Bacterium comes Bersteyn. (Arb. bakt. Inst. Karlsruhe, 3, 1903, 93.) From soil.

Bacterium compactum (Kruse) Migula. (Bacillus compactus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 353; Migula, Syst d Bakt., 2, 1900, 433) From air.

Bacterium concentricum Kern, (Arb bakt Inst. Karlsruhe, 1, Heft 4, 1896, 437.) From the intestines of birds. Bacterium conjunctivitidis (Kruse) Mi-

gula. (Koch, Berichte aus Aegypten an den preuss. Staatsminister des Innern; see Arb. a d. kaiserl Gesundheitsamte, 3, 1887; Kartulis, Cent. f. Bakt., 1, 1887, 289, Bacillus aegyptius

Trevisan, I generi e le specie delle Batternacee, 1859, 13; Bacillus conjunctivitatis Kruse, in Flugge, Die Mikrorganismen, 3 Aufl., 2, 1896, 440, Bacterium conjuncituitis Chester, Ann Rept Del. Col. Agr. Exp. Sta. 9, 1897, 67, Migula, Syst. d. Bakt., 2, 1900, 509, not Bacterium conjunctivitidis Chester, Man. Determ. Bact., 1901, 120, Bacterium acgyptium Chester, the J. 121.) Associated with conjunctival catarrh in Egynt.

Bacterium corticale (Haenlein) Migula (Bacillus corticalis Haenlein, Deutsch. Gerberzeitung, 1894, No. 18-34, Migula, Syst. d. Bakt., 2, 1900, 449) Found on pine bark; in acid dyenne-liquer

Bacterium crenatum Weiss (Arb bakt Inst. Karlsruhe, 2, Heft 3, 1902, 221.) From fermenting malt.

Bacterium cristalliferum Gicklhorn (Cent. f. Bakt., II Abt., 50, 1920, 420) A sulfur bacterium from soil. See Manual, 5th ed., 1939, 86 for a description of this organism.

Bacterium cuticularis (Tils) Chester. (Bacillus cuticularis Tils, Ztschr f. Hyg., 9, 1890, 293, Chester, Ann Rept Del. Col. Agr Exp. Sta., 9, 1897, 105) Prom water.

Bacterium debite Berstyn. (Arb bakt Inst. Karlsruhe, 5, 1903, 96) From soil. Bacterium delendae-museae Roubaud and Descazeaux (Compt. rend. Acad Sci., Paris, 177, 1923, 716) From fly larvae (Stomozys calcitrans and Musea domestica)

Bacterium deliense Honing (Cent f. Bakt., II Abt, 57, 1913, 377) From tobacco plants in Sumatra

Bacterium diatrypeticum Migula (Bacillus diatrypeticus case: Baumann, Landwirtsch. Versuchsstationen, 42, 1893, 181; Migula, Syst d. Bakt , 2, 1900, 401) Trom cheese.

Bacterium enchelys Ehrenberg (Ehrenberg, Abhandl d. Akad. d Wissensch. zu Berlin, 1830, 61, Bacillus enchelys Trevisan, I generi e le specie delle Batteriacee, 1889, 18) From water. Bacterium endocarditidis Migula.
(Bacullus endocarditidis capsulatus
Weichselbaum, Beitr. z. pathol. Anat.
u z. aligem. Pathol., 4, 1887, 197, Migula,
Syst. d Batt, 2, 1900, 399.) Found in
the aorta, the left ventricle, the splicin
and kidneys of cadavers.

Bacterium endometritidis (Kruse) Chester. Bacilius endometritidis Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 432; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 88.) From a liver abscess.

Bacterium endometritis canis Meyer. (Meyer, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 77; Plocomobacterium endometritis Pribram, idem.) From a case of endometritis in a dor.

Battruum enterocoliticum Schleifstein and Coleman. (A motile, Gram-negative bacillus, Schleifstein and Coleman, N. Y. State Jour. Med , 52, 1939, 1749; Ann Rept Div. Lab. and Ries, N. Y. State Dept. Health for 1943, 56) From lesions about the face, from an ulcer in the intestine and from the intestinal contents. Resembles Bacillus lignieri and Pastertella pseudotiverulosis.

Bacterium erythromyza (Zopf) Migula. (Micrococcus) erythromyza Zopf, Ber. d deutschen bot. Gesellsch, 1891, 22; Rhodococcus erythromyza Zopf, loc. ct., Migula, Syst d. Bakt., \$, 1900, 487, Bacillus erythromyza Acquischita, Bakt., \$, 200, 187, Bacillus erythromyza Micrococcus coccus of the control of the c

Bacterium exanthematicum (Krise) Chester (Bacille, Babes and Oprescu, Ann Inst. Past , 5, 1891, 273, Bacillus exanthematicus Krise, in Flügge, Die Mikroorganismen, 3 Auft, 2, 1890, 429 Chester, Ann. Rept Del Col. Agr. Exp. Sta , 9, 1897, 87) From a case of hemorrhagie septicemia.

Bacterum fausseki Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 157) Prom sea water.

Bacterium ferophilum (sic) Migula

(Die ferrophilen Bakterien, Marpmann, Cent. f. Bakt., II Abt., 4, 1898, 21; Migula, Syst. d. Bakt., 2, 1900, 455 and 1058.) Isolated during studies on black discoloration of cheese.

Bacterium finitimum Chester (Bacillus finitimus ruber Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 361; Bacterium finitimus ruber Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 116; Chester, Man. Determ. Bact., 1901, 177.) From air.

Bakterium flaveum Wilhelmy. (Arb. bakt Inst. Karlsruhe, 3, 1903, 15.) From meat extract

Bacterium flatocoriaceum (Lisenberg) Chester. (Schwefelgelber Bacillus, Adamets and Wiehmann, Die Bakterien der Trink- und Nutzwässer, Mitt. Oest. Versuchsstat. f. Brauerer a. Mälz., Wien, Heft 1, 1888, 49; Bacillus flavocoriaceus Eisenberg, Bakt. Diag., 3 Aufl., 1881, 144; Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 112) From water

Bacterium flavofuscum Migula (No. 9, Lembke, Arch. f. Hyg., 28, 1896, 304; Migula, Syst. d. Bakt., 2, 1900, 479.)
From meat.

Bacterium flavum Issatchenko. (Recherehes sur les microbes de l'Océan Glacial Arctique (in Russian) Petrograd, 1914, 151) From sea water.

Bacterium folicola (Miche) de Jongh (Bacillus folicola Miche, see Jahrb wiss Bot., 53, 1914, 1, thd, 53, 1919, 29; de Jongh, On the Symbiosis of Ardista trispa Thesis, Univ Leiden, 1938, 33) A haeterial symbiont isolated from germinating seeds and embryos

Bacterium freundn Migula. (Bacillus nova species I, Freund, Inaug. Diss., Erlangen, 1893, 31; Migula, Syst. d Bakt., 2, 1900, 472) From the mouth cavity.

Bacterium fungoides (Tschistowitsch) Migula. (Bacillus fungoides Tschistowitsch, Berl klin. Wochnschr., 1892, 513; Migula, Syst. d. Bakt., 2, 1900, 391.) From pus.

Bacterium fuscum (Flugge) Migula.

(Bacillus fuscus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 290; Migula, Syst. d. Bakt., 2, 1990, 463.) From water.

Bacterium gamma (Dyar) Chester. (Bacillus gamma Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 367; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 106) From air.

Bacterium gammari Vejdovsky. (Cent. f. Bakt., II Abt., II, 1904, 481) From sections of a fresh water crustaccan (Gammarus zschokkei). Cells exhibit nuclei, showing mitosis.

Bacterium gelechiae No. 1 and No. 2, Metalnikov and Metalnikov. (Compt. rend. Acad. Agr., France, 18, 1932, 2015) From dead and dying larvae of a moth (Gelechia gossypiella).

Hocterium gelechiae No. 5, Metalnikov and Meng. (Compt. rend. Soc. Biol, Paris, 113, 1933, 170.) From dead larvan of a moth (Gelechia gossypielle). Bacterium gemmiforme Migula.

Hacterium gemmiforme Migula. (Lembke, Arch. I. Hyg., 29, 1897, 313; Migula, Syst. d. Bakt., 2, 1900, 391.) From intestinal contents. Bacterium gibbosum Weiss. (Arb.

bakt. Inst. Karlsruhc, 2, Hett 3, 1002, 230.) From fermenting beets and malt Bacterium gingirae pyogenes Miller, (Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1883, 217; Baciltus gingitae pyogenes Sternberg, Manual of Bact,

Flugge, Die Mikroorganismen, a Auu., -, 1896, 427, Migula, Syst. d. Bakt., 2, 1900, 393 ) Isolated in an epidemic of seurvy in Jassy.

Bacterium gliscrogenum Malerba and Sanna-Salaris (Malerba and Sanna-Salaris, Lavori eseguiti nell'Istituto lisioi. di Napoli, 2, 1883, 13 and 95, Bacillus gliscrogenus Trevisan, I generi e le specie delle Batteriacee, 1889, 14) From urine

Bacterium gonnermanni Migula. (Bacillus tuberigenus 6 Gonnermann, Landwirtsch. Jahrb , 25, 1894, 657; Migula, Syst. d Bakt., 2, 1900, 418) From root nodules of lupine.

Bacterium gracilescens Weiss (Arb bakt, Inst. Karlsruhe, 2, Heft 3, 1902, 259.) From fermenting asparagus and malt.

Bacterium gracullimum Weiss (Arb bakt, Inst. Karlsruhe, 2, Heft 3, 1902, 235.) From bean and asparagus infusions.

Bacterium granulatum Henrici (Henrici, Arb. bakt Inst Karlsruhe, 1, Heft 1, 1894, 33; not Bacterium granulatum Chester, Man. Determ Baet , 1901, 189 ) From cheese.

Bacterium granulosum Weiss (Weiss, Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902. 212; not Bacterium granulosum Lehmann and Neumann, Bakt Diag, 5 Aufl, 2, 1912, 306) From vegetable infusions

Bacterium gryllotalpae Metalnikov and Meng. (Compt rend Acad Sci., Paris, 201, 1935, 367.) From diseased larvae of the cricket (Grillotalpa gryllotalpa)

Hacterium gumnosium Ritsert (Rit seet, Ber, d. pharmaz Gesell, 1, 1891, 389; abst in Cent f Bakt, 11, 1892, 730; Bacillus gummosius Migula, Syst d. Bakt, 2, 1900, 573) A mysture of a spore-forming rod and a streptocuccus See Bacillus gumnosius Happ and Vicco-coccus gumnosius Happ and Vicco-coccus gumnosius Happ.

Bacterium halans (Zimmermann) Mi gula. (Bacillus halans Zimmermann, Die Bikterien unserer Trink- u Nutzwässer, Chemnitz, 2, 1894, 54, Migula, Syst. d Bikt, 2, 1900, 129) From water.

Bacterium hebetisiccus Steinhaus. (Jour. Bact., 42, 1911, 762 and 773) From the walking stick (Diapheromera femorata)

Bacterium herbicola a aurum Geilinger (Mitteil a d Geliete d Lebensmitteluntersuchungen u Hyg., 12, 1921, 262) From corn meal This is a variety of Bacillus herbicola Burri and Düggeli.

Bacterium lerbicola rubrum Düggeli. (Düggeli, Cent. f. Bakt., II Abt., 12, 1904, 605, Bacterium herbicola β rubrum Lehmann and Neumann, Bakt. Diag , 4 Aufl , 2, 1907, 356 ) From germinating plants, roots and harley seeds

Bacterium hexacarbororum Störmer (Jahresber d Vereinigg f angew Botanik, 6, 1907, 116) From soil Utilizes benzene and certain benzene derivatives

Bacterium hidium Goobin (Russian Health Resort Service, 5, 1923, 3) Attacks ethane and other hydrocarbons.

Bacterium hirudinicolicum Lehmensick (Cent f Bakt, I Abt, Orig, 147, 1941, 317, see Biol Abst, 18, 1941, No. 6761) Symbiotic in the intestines of Hirudo officinalis and H. medicinalis

Bacterium hoshigaki var. glucuronicum II and III Takahashi and Asai. (Cent f Bakt, II Abt, 87, 1933, 395 and 405) From dried persimmons (hoshigaki)

Bacterium infectualum Chester (Baeillus filiformis haranienis Steinberg, Man of Bact , 1893, 650, Bacterium filiformis haranienis Chester, Ann Rept. Del Col Agr Exp Sta , 9, 1897, 126, Chester, Man Determ Bact , 1201, 181 ) I rom the liver of a yellow fever cadaver Amerobic

Bacterium inocuum Chester (Wilde, Wien klin Wordnschr, 1892, No. 1-2; Bacillus lactis inocuus Kruse, in Hügge, Die Mikriorganismen, 3 Aufl. 2, 1896, 332, Bacterium lactis inocuus Chester, Ann Rept Del Col. Agr. Exp. Sta., 9, 1907, 82, Chester, Man. Determ. Bact., 1901, 138 - 17 mm milk.

Bacterium intrinsectum Steinhaus (Jour Bact , 42, 1911, 764 and 771) From an unidentified leaf beetle.

Bacterium togenum Brumgstiner (Deutsche Monatschr I Zuhnleille, 27; 761, Bacterium jogenum Brumgstiner, Ergels d gesim Zshinelli J., 1911, 73; and 779, B. togenurs Kligler, Jour. Albed Dant. See, 10, 1915, 152). From the nouth. Regarded as identical with Jodoveccus raginatus Miller by Kligler (lee, cit.).

Bucterium keratomalaciae Miguls. (Bacillus septicus keratomalaci se Bales, Bakteriol. Untersuch. d. sept. Prozesse d. Kindesalters, Leipzig, 1889; Migula, Syst. d. Bakt., 2, 1900, 363.) From an infected cornea.

Racterium Inipowitchi Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 150.) From sea water. A phosphorescent bacterium found to be pathegonic for the mealworm (Tenebrio molitor) by Pfeifer and Stammer (Zischr. f. Morph. u. Okol. d. Tiere, 20,

1930, 157).

Bacterium kralii (Dyar) Chester.
(Bacillus kralii Dyar, Ann. N. Y. Acad.
Sci., 8, 1895, 376; Chester, Ann. Rept.
Del. Col. Agr. Exp. Sta., 9, 1897, 93; not
Bacterium kralii Chester, Man. Determ.
Bact., 1901, 166) Received as Bacillus
butyricus from Krhl's laboratory by
Dyar. The 1900 Krhl Catalogue lists
cultures of Bacillus butyricus Botkin and
Bacillus butyricus Hueppe. As Dyar
found that the characters of his culture
differed from those of Bacillus butyricus
Hueppe, Dyar's culture was probably
Bacillus butyricus Botkin.

Bacierum kralii Chester. (Bacillus fuscus liquefaciens Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 375; Bacterium fuscus liquefaciens Chester, Ann. Rept. Del Col. Agr Exp Sta., 9, 1897, 103, Chester, Man. Determ Bact., 1901, 166.) Received as Bacillus fuscus from Kral's faboratory by Dyar who also found it inst. The 1920 Kral catalogue lists Bacillus fuscus Flugge syn. Bacterium brunneum Schrotter (sic), braunrother Bacillus Maschek

Bacterium laeru Migula. (Bacillus viscosus No. 1, van Laer, Extrait des mémoires couronnés et autres mémoires, Acad. Royale de Belgique, 1889, 36; see Kramer, Bakteriol. in ihren Besiehungen zur Landwirtsch. 9, 1892, 119; Bacillus viscosus cerevisiae Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 539, Bacterium viscosus cerevisiae Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 78; Migula, Syst. d. Bakt., 2, 1900, 402; Bacterium viscosum Chester, Man.

Determ. Bact., 1901, 128.) From beer, yeast, air, bread. Causes a slimy fermentation.

Bacterium laevolacticum Migula. (Bacillus acidi laevolactici Schardinger, Monatsh. f. Chemie, 11, 1890, 544; Migula, Syst. d. Bakt., 2, 1900, 406; Bacterium acidi laevolactici Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 178.) From milk.

Bacterium laminariae Billet. (Compt. rend. Acad. Sci., Paris, 106, 1888, 233, Billetia laminariae Trevisan, I generie le specie delle Batteriacce, 1889, 11; Kurthia laminariae De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 931.) From rotting sea weed. The type species of the genus Billetia Trevisan.

Bacterium langkatense Honing. (Cent. f. Bakt., II Abt., 57, 1913, 381) From tobacco plants in Sumatra.

Bacterium largum (v. Klecki) Migula. (Bacillus largus v. Klecki, Ann. Inst Past., 9, 1898, 728; Migula, Syst. d Bakt., 2, 1900, 448.) From the intestines of dogs.

Bacterium lepierrei Chester. (Baeille fluorescent pathogène, Lepierre, Ann. Inst. Past., 9, 1895, 643; Chester, Man. Determ. Baet., 1901, 182.) From cistern water.

Hacterium lethalis (Babes) Chester.
(Proteus lethalis Babes, Progrès Médical

1901, 240.) From lung gangrene in man. Bacterium leucaemiae Migue, (Lucet, Jahresber, G. Fortschr. in d. Leine v. d. path. Mikroorg., 7, 1891, 319; Bacillus leucaemiae canis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 285, Bacterium leucaemiae canis Chester, Ann. Rept. Del. Col. Agr. Evp Sta., 9, 1897, 119; Migula, Syst. d. Bakt., 2, 1900, 442, Bacillus leucaemiae Chester, Man. Determ. Bact., 1901, 264.) From a dog with leukemis.

Bacterium limbatum Migula. (Bacterium limbatum acidi lactici Marpmann, Ergänzungshefte d. Centralb. f. allg. Gesundheitspflege, 2, 122; Bacillus limbatus acid lattici Sternberg, Man. of Bact., 1893, 645; Migula, Syst. d. Bakt., 2, 1900, 407.) From fresh milk

Bacterium lincola (Müller) Cohn (Vibrio lincola Müller, Vermum Historin, 1773, 39; Cohn, Beitr z Biol d Pflanz, I, Heft 2, 1872, 170, Bacillus lincola Trevisan, I generi e le specie delle Batteriacce, 1889, 18) From stagnant water, influsions etc.

Bacterium lini Migula. (Winogradsky, Compt. rend. Acad. Sci., Paris, 121, 1693, 742; Migula, Syst. d. Bakt., 2, 1900, 513.) From retting hemp

Bacterium linloi Issatchenko (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian) Petrograd, 1914, 154) From sea water.

Bacterium liquefactums communus (Sternberg). Chester. (Bacillus lique-factum communus Sternberg, Man of Bact., 1893, 686, Chester, Ann Rept Del. Col. Agr. Exp. Sta. 9, 1897, 91. Bacillus communis Migula, Syst d Dakt., 9,1007, 725; not Bacillus communis Juckson, Jour. Inf. Dis., 8, 1911, 241) From the feces of yellow fever patients

Bacterium litoreum Warming. (Warming, Danmarks Kyster levende Bakterier, 1875, 398, Bacillus litoreus Trevrsan, I generie le specie delle Batteriacce, 1880, 18.) From sea water

Bacterium Ioculosum Migula. (Fācherbacillus, Clauss, Inaug. Diss., Würzburg, 1889, 27; Migula, Syst d Bakt, 2, 1900, 408) From milk

Bacterium luceti Migula (Lucet, Ann. Inst. Past., \$1, \$1839, 401, Bacillus cuniculicida thermophilus Kruse, un 11ügge, Die Miktoorganismen, 3 Aufl, § 1896, 418, Migula, Syst., d Bakt, £, 1900, 507, Bacterium cuniculicida thermophilus Chester, Ann. Rept. Del Col Agr. Exp Sta, 9, \$1807, 83; Bacterium cuniculicida Chester, Man. Determ Bact, 1901, 140) Associated with an epirootic in rabbits and guinea pigs

Bacterium ludwigi Karlinski. (Hyg Rundschau, 5, 1895, 685.) From the water of the hot springs at Ilidze in Bosnia.

Bacterium luteolum Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1594, 51, Migula, Syst. d Bakt, 2, 1900, 455) From cheese

Bacterium Intescens Migula, (Der gelbe Bacillus, Lustig, Diag d Bakt, d Wassers, 1893, 78, Migula, Syst d Bakt, 2, 1900, 476) From water

Bacterium Iuteum Adametz. (List, Inaug Dies, Leipzig, 1853, 53, Adametz, Bakt Nutz- u. Trinkwässer, Mitteil. d. osterr Versuchsstation für Brauerei und Malzerei in Wien, 1883, 48.) From the stomach contents of sheep and from

Bacterium margarineum Migula. (Margarinbacillus α, Jolles and Winkler, Ztschr f Hyg., 20, 1895, 102, Migula, Syst d. Bakt, 2, 1900, 410.) From margarine.

Bacterium marinum Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 238) From sea water

Bactersum maydis Maiocchi (Maiocchi, Bollet d Accad medic d Roma, October, 1881, Bacillus maydis Trevisan, I generi e le specio delle Batteriacec, 1889, 17) From corn (maize) infusions

Bacterium medanense Honing (Cent f Bakt, II Abt, 37, 1913, 382) From the peanut plant (Arachis hypogaea).

Bacterium meiolonthae liguefaciens Paullot (Compt rend Soe Biol., Paris, 88, 1916, 1102) From the cockchafer (Melolontha metolontha) According to the author's system of nomenclature, this is presumably a synonym of Bacillus melolonthae liguefaciens.

Bacterium meningitidis (Neumann and Schaffer) Chester (Bacillus meningitidis purulentae Neumann and Schreffer, Arch f pith Anat, 109, 187, 477; Chester, Ann Rept Del Col Agr. Livy Sta. 9, 1897, 71, Bacillus neumanni Migula, Syst d Bakt, 2, 1900, 731; not Bacillus neumanni Herter, in Just, Botan Jahresber, 2 Abt., 59, 146t 4, 1915, 748, Bacillus meningidis Chester, Man. Determ. Bact., 1901, 213.) From pus from an individual who died of purulent meningitis.

Baclerium merismopedioides Zopf. (Zopf. Die Spaltpilze, 1 Auff., 1883, 56; Bacillus synchyseus Trevisan, I generie le specie delle Batteriacee, 1889, 18; Baclerium synchyseus DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1859, 1022.) Front canal water.

Bacterium microsporum Trevisan. (Trevisan, Rendic. d Instit. Lombardo, Ser. 2, 15, 1870; Bacillus microtis Trevisan, I generie le specie delle Batteriacce, 1889, 18; Bacterium microtis DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1025.) From water and putterfying infusions.

Bacterium minutum (Zimmermann) Migula. (Bacillus minutus Zimmermann, Die Bakterien unserer Trink-und Nutzwasser, Chemnitz, 2, 1894, 56; Migula, Syst. d. Bakt., 2, 1990, 423.) From water.

Bacterium monachae von Tubeuf. (v. Tubeuf. Forstlich - naturwissensch. Zischr., 1, 1892, 34; Bacillus monachae Migula, Syst. d. Bakt., 2, 1900, 742.) From the larvae of a moth (Lymantria monacha).

Bacterium multipediculum (Flugge) Chester. (Bacillus multipediculus Flugge, Die Mikroorganismen, 2 Auft, 1886, 233; Chester, Ann. Rept. Del Col. Agr. Evp. Sta, θ, 1897, 104) Isolated frequently us a contamination on pointo media.

Bacterium muripestifer (Kruse) Chester. (Bacillus der Mauseseuche, Laser, Cent. f. Bakt, 11, 1892, 184; Bacillus muripestifer Kruse, in Flugge, Die Microorganismen, 3 Aufl., 2, 1896, 432; Chester, Ann. Rept Del. Col. Agr. Exp Stn. 9, 1897, 87.) From the spleen of a field mouse. Associated with a plague of field mice.

Bacterium nacreaceum (Zimmermann) Migula. (Perlmutterglänzender Bactllus, Keck, Inaug Diss., Dorpat, 1890, 40; Eberbach, Inaug. Diss., Dorpat, 1890; Bacillus nacreaceus Zimmermann, Die Bakterien unserer Trink- und Nutzwässer, Chemnitz, 2, 1891, 34; Migula, Syst. d. Bakt., 2, 1900, 426.) From water.

Bacterium naphthalinicus Tausson (Planta, 4, 1927, 214) From oil-soaked soils at Baku, Russia. Oxidizes naphthalene.

Bacterium nicolaieri Migula. (Kapselbacillus, Nicolaier, Cent. f. Bakt, 16, 1894, 601; Migula, Syst. d. Bakt, 2, 1900, 354.) Associated with purulent nephritis.

Bacterium nicotianum Bucherer. (Cent. f. Bakt., 11 Abt., 105, 1942-43, 446.) From fermenting tobacco leaves. Bacterium nicotinobacter Bucherer. (Cent. f. Bakt., 11 Abt., 105, 1942, 170) From a mixture of soil, manure and rotting materials. Gram-variable.

Bacterium nicotinophagum Bucherer. (Cent. f. Bakt., II Abt., 105, 1942, 167.) From a mixture of soil, manure, and rotting materials. Also from fermenting tobacco leaves (tbtd., 446).

Bacterium nitens Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 459) From the intestines of birds.

Bacterium nomae (Schimmelbusch) Migula. (Bacillus nomae Schimmelbusch, Deutsch. med. Wochnschr., 1889, No. 26; Migula, Syst. d. Bakt., 2, 1900, 384.) Found in necrotic tissues.

Bacterium oblongum (Boutroux) De-Toni and Trevisan. (Micrococus of longus Boutroux, Annales de l'École normale supérieure, Sér 2, 5, 1831, 67. Bacillus oblongus Trevisan, I generi e le specie delle Batteriacce, 1889, 16; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1021; Bacterum gluconteum Miquel and Cambier, Traité de Bact, 1002, 605; not Bacterium gluconicum Hermann, Biochem. Zeit, 192, 1928, 198) From vinegar. May be an acetobacter.

Bacterium ogatae Migula. (Ogata, Cent f. Bakt., 9, 1891, 442; Migula, Syst d. Bakt., 2, 1900, 389) From dust.

Bacterium orchiticum (Kruse) Chester. (Bacillus zur Rotzdiagnose, Kutscher, Ztschr. f. Hyg., 21, 1895, 156; Bacıllus orchiteus Kruse, in Flugge, Die Mikroorganismen, 3Aufl., 2, 1890, 455 Cheste, Ann. Rept. Del. Col. Agr. Evp Sta., 9, 1897, 90) From nasal secretions of a glandered horse.

Bacterium esteophilum Billet (Contribution à l'étude de la morphologie et du développement des Bactériacées, Bull. Sci de la France et de la Belgique, Paris, 21, 1890, 149) From macerated human bones.

Bacterium orale Migula (Bacillus No. 17, Pansini, Arch f. pathol Anat u Physiol, 122, 1890, 451, Migula, Syst d. Bakt., 2, 1900, 453; not Bacterium orale Chester, Man Determ Bact, 1901, 171 (Bacillus oralis Wright, Mem Nat Acad, Sci., 7, 1895, 435). From feccs

Bacterium ocatium Migula (Bacillus ocatius minutissimus Unna-Tommasoli, Monatsh f. prakt Dermatol, 9, 1889, 59; Migula, Syst d Bakt, 2, 1900, 417, Bacterium ocatius minutissimus Chester, Ann Rept. Del Col Agr Evp Sta, 9, 1897, 139, not Bacterium ocatium Chester, Man. Determ. Bact, 1901, 177 (Bacillus ruber ocatus Bruyning, Arch néerl Sci exact, et nat, Sér. II, 1898, 297) From human skin with seborhene oceroma

Bacterium pallens Henrici (Arb bakt, Inst. Karlsruhe, 1, Heft 1, 1894, 36) From cheese

Bacterium pallescens Henrici (Arb bakt. Inst. Warlsruhe, 1, Heft 1, 1894, 35) From cheese

Bacterium pallıdum Henrici (Arb bakt. Inst Karlsruhe, 1, Heft 1, 1891, 31, Ultına pallıda Pribram, Klassifkation der Schizomyceten, Leipzig und Wien, 1933, 76) From cheese

Bacterium pallidor Chester. (Bactilus fueus pallidor Dyar, Ann N Y Acad, Sci., 8, 1805, 361, Bacterium fuscus pallidor Chester, Ann Rept Del Col Agr. Exp Sta., 9, 1897, 111; Chester, Man Determ Bact., 1901, 171) Culture received by Dyar from Krål's laboratory labeled Bacillus latericeus. Dyar renames this because the culture does not agree with Bacillus latericeus does not agree with Bacillus latericeus. Eisenberg Honever, the 1900 Krall catalogue indicates that this was Bacillus latericeus Adametz and Wichmann syn ziegelrother Bacillus, Adametz, Bacterium lactericeum Lehmann and Neumann

Bacterium papillare Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 149) From sea water.

Bacterum paradoxus (Kruse) Chester. (Typhus ahnheher Bacillus, Kruse and Pasquale, Zischr f Hyg, 16, 1894, 19) Bacillus paradoxus Kruse, in Flugge, Die Mikroorganismen, 3 Aufi, 2, 1896, 373; Chester, Ann Rept Del Col Agr. Live, Sta, 9, 1807, 71) From the liver in a case of dyscalery.

Bacterium paraviscosum Buchanan and Hammer (Iona Sta Coll Agr. Exp Sta, Res Bull 22, 1915, 266) Stated to be similar to Bacterium viscosum of various authors

Bacterium patelliforme Honing. (Cent f Bakt , II Abt , 37, 1913, 378) From tobacco plants in Sumatra

Bacterium pateriforme Migula. (Bacillus abicans pateriforms Unna-Tommisoli, Monatsh prakt Dermatol, 9, 1889, 58; Migula, Syst d Bakt, 2, 1900, 415) Found on human skin with sebortheic ecrema.

Bacterium petersii Migula. (Bacterium C, Peters, Botan. Zeitung, 47, 1889, Bacillus aceticus petersii Kriuse, in Flugge, Die Mikroorganismen, 3 Aufl, 4, 1896, 355, Bacterium aceticus petersii Chester, Ann. Rept. Del Col. Agr Evp Sta. 9, 1897, 77, Migula, 89xt. d Bakt. 2, 1900, 397, Bacterium aceticum Chester, Man Determ Bact, 1901, 127, not Bacterium aceticum Baginsky, Zischr. f., phys Chem. 12, 1888, 437) From fermenting dough

Bacterium photometricum Engelmann. (Lingelmann, Jour Roy, Microscop Soc., 1882, 656 and 1883, 256; Bacillus photometricus Trevisan, 1 generi e le specie delle Butteriacee, 1889, 18.) Saprophytic.

Bacterium piluliformans (Müller-Thur-

gan) Migula. (Bacillus viluliformans Miller-Taurgan, Jahresber, d. Verenchestation zu Wadenswil 1892/3, 3, 1834, 92; Migula, Syst. d. Bakt., 2, 1990, 513.)

From a disease of red wine.

L'acterium pituitorum Migula. (Bacillus loctis pituitosi Lieffer, Berliner klin. Wochnschr., 1587, 631; Bacterium lactis pituitori Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 86; Migula, Syst. d. Bakt., 2, 1900, 403; Bacterium lactic Chester, Man. Determ. Bact .. 1901, 148; not Bacterium lactic Baginsky, Ztschr. I. phys. Chem., 12, 1888, 437.) From milk

Bacterium pityocampae Dufrency. (Compt. rend. Soc. Biol., Paris, 71, 1919, 288.) From diseased caterpillars of the processionary moth (Cnethocampa pityo-

campa)

Bacterium pleuropneumoniae Migula. (Diplococcus der Brustseuche Pferde, Schutz, Arch. f. pathol. Anat. u. Physiol., 107, 374; Migula, Syst. d. Bakt., 2, 1900, 348) Frequently isolated from horses with pneumonia.

Bacterium plicatum (Zimmermann) Chester (Bucillus plicatus Zimmermann. Die Bakterien unserer Trink- und Nutzwäeser, Chemnitz, 1, 1830, 54; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., D. 1807, 108; Bacterium plicativum Migula, Syst. d. Bakt., 2, 1900, v and 453). From water.

Bacterium pneumopecurium Chester. (Bacillus of sporadic pneumonia of cattle, Smith, U. S. Dept Agr. Bur. Animal Husbandry, 1895, 136; Chester, Man. Determ. Bact , 1901, 137.) Similar

to Pasteurella suilla.

Bacterium pneumosepticum (Babes) (Bacillus pneumosepticus Migula. Babes, Progrès méd. roumain, 6, 1889; not Bacillus pneumosepticus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 408; Migula, Syst. d. Bakt., 2, 1900, 377.) From a case of septic pneumonia.

acterium polymorphum (Frankland rankland) Migula. (Bacillus polyus Frankland and Frankland, Philos. Trans. Royal Soc. Loning 37. 1587, B, 275; Migula, Syst. d. Eut., 1900, 420.) From air.

Bacterium porri Majocchi. Maje. chi, in Tommssi-Crudeli, America patologica, 1, 1882; Bacillus rerressiragaris Kuhnemann, Monatsh. I. prakt. Dermatol., 9, 1889; Bacillus porri Troisan, I generi e le specie delle Batteria:-1539, 13.) From warts.

Bacterium prodeniae Metalnikov and Metalnikov. (Compt. rend. Arai Agric., France, 18, 1932, 206.) From a blackened dead larva of a moth (Prodenia litura).

Bacterium profusum (Frankland and Frankland) Migula. (Bacillus profusts Frankland and Frankland, Philos. Trans Royal Soc. London, 178, 1887, B, 276, Migula, Syst. d. Bakt., 2, 1939, 421.) From air.

Bacterium pseudoaquatile Miguls. (Bacillus aquatilis a, Tataroff, Inaug. Diss., Dorpat, 1891, 44; Migula, Syst. d Bakt., 2, 1900, 470.) From water.

pseudoconjunctivitisis Bacterium (Kruse) Chester. (Kartulis, Cent. f. Bakt., 1, 1887, 289; Bacillus pseudoconjunctivitidis Kruse, in Flügge, De Mikroorganismen, 3 Aufl., 2, 1896, 411; Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1897, 108.) From conjunctival decretions.

Bacterium pseudofilicinum Migula. (Fadenbacillus, Maschek, Bakteriologische Untersuchungen der Leitmentzer Trinkwässer, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2, 1900, 451.) From water.

Bacterium pseudoinfluenzae (Kruse) (Pseudoinfluenzabacillus, Chester. Pfeiffer, Zischr. f. Hyg., 18, 1893, 357; Bacillus pseudoinfluenzae Krusc, in l'lügge, Die Mikroorganismen, 3 Aufl, 2, 1896, 439; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 66.) From

Racterium pseudokeratomalaciae Miwater. gula. (Ioeb, Cent. f. Bakt., 10, 1891, 369; Migula, Syst. d. Bakt., £, 1900, 359.)



A capsulated bacterium from infected cornea of a child.

Bacterium pscudomultipedieulum Miguls. (Bacillus multipedieulus flavus Zimmermann, Balt. unser Truh- u Nutzwässer, Chemnitz, 2, 1894, 42, Migula, Syst. d. Bakt., 2, 1900, 332) From senace.

Bacterium pseudopneumonicum (Passet) Chester. (Bacillus pseudopneumonicus Passet, Untersuchungen uber die Acticlogie der eiterigen Phlegmone des Menschen, 1885, 40; Chester, Ann Rept Del. Col Agr. Exp Sta, 9, 1897, 140, Brucella pseudopneumonicum Pribram, Klassifikation der Schuconyceten, Leipig und Wien, 1933, 68 ) From pus

Bacterium punctum (Mueller) Ehrenberg. (Monas punctum Mueller, Infusoria, 1786, 3, Bacillus punctum Trevisan, I generie le specie delle Batteriscee, 1859, 18.) From swamps and stagnant water.

Bacterium putidum Chester (Bacullus graculus cadaucris Sternberg, Man of Bact., 1893, 733, Chester, Man. Determ Bact., 1901, 140) From a liver

Bacter, 1801, 140) I from a liver Bacterium Migula (Levy, Cent. f. klin. Med., 1890, No 4, abst in Cent. f. Bakt, 8, 1890, 88, Migula, Syst d. Bakt., 2, 1900, 443) From a case of byemia.

Bacterium pyocinnabareum (Kruse) Clester. (Ferchmin, Ueber rote Eterrung, Wratsch, 1892, No 24 and 25, abst. in Cent f. Bakt, 15, 1893, 103, Bacillus pyocinnabareus Kruse, in Flugge, Die Mikroorganisem, 3 vul 4, 2, 1896, 304; Chester, Ann Rept. Del Cel Agr. Exp Sta., 9, 1897, 113) From a case of red pus

Bacterium pyogenes Chester. (Fuchs, Inaug Diss., Greifswald, 1890, Bacillus pyogenes ancerobus Kruse, in Pfüger. Die Mikroorganismen, 3 Aufl. g., 1896, 244; not Bactlus pyogenes anaerobus Pkla-Johan, Cent. f. Bakt., I Abt., Ong., 87, 1922, 200; Bacterium pyogenes anaerobus Chester, Ann. Rept. Dcl. Col. Agr. Exp. Sta., g., 1897, 127, Chester, Man. Determ Bact., 1901, 184; not Man. Determ Bact., 1901, 184; not

Bacterium pyogenes Migula, Syst. d. Bakt, 2, 1900, 381, not Bacterium pyogenes Ward, Jour. Bact, 2, 1917, 619.) From stinking pus from a rabbit.

Bacterum pyraustae Nos. 1-7 Metalnilov and Chorine (Internat Corn Borer Invest, Sci Repts., 1, 1928, 52.) From diseased corn borer larvae (Pycousta nyhalitis Hb.).

Bacterium radialum Chester. (Del. College Agr Expt Sta Ann. Rept., 11, 1900, 56 ) From soil

Bacterium ramificans Weiss (Arb. bakt Inst. Karlsruhe, 2, Heft 3, 1902, 229) From bean infusions

Bactersum rangsferinium Honing, (Honing, Cent. f. Bakt., II Abt., 87, 1913, 379, Plocamobactersum rangsferinium Pribram, Klassifikation der Schizomyceten, Lepzig und Wien, 1933, 78.) From fermenting tobacco

Bacterium repens Miche. An organism associated with Bacterium folicola de Joneh

Bacterium retiformans Gicklhorn. (Cent f Balt, II Abt, 50, 1920, 421.) A sulfur bacterium from garden soil. See Manual, 5th ed, 1939, 86 for a description of this organism

Bactersum rhizopodicum Migula. (Bacillus rhizopodicus margarineus Jolles and Winkler, Zischr f Hyg., 20, 1895, 105, Migula, Syst d Bakt, 2, 1900, 452.) From margarine

From inargatuse
Bacterium roseum Lossli (Lossli,
Inaug Diss, Dorpit, 1893, quoted from
Migula, Syst d. Bakt, 2, 1900, 484;
Bactlius roseus Nepveux, Thèse, Pac.
Pharm, Pans, 1929, 115 J. From sand.
Bacterium rubipenosum Kern. (Kern,
Arb bakt, Inst. Karlsruhe, 1, Heft, 4,
1800, 456, Bacillus rubipenosus Nepveux,
Thèse, Fac Pharm, Paris, 1920, 113;
not Bacillus rubiginosus Catiano, in
Cohn, Bettr z Biol d Pflancen, 7, 1856,
585 ) From the intestines of birds.

Bacterium rubrum Schneider. (Balterium rubrum Schneider, Arb. bakt. Inst Karlsrühe, 1, Heft 2, 1894, 213, also see Migula, Syst d Bakt., 2, 1990, 488. Bacillus rubrum Nepveux, Thèse, Fac. Pharm., Paris, 1920, 115.) From swamp water. Difficult to distinguish from Bacterium eruthromyza.

Bacterium rubrum Metalnikov and Metalnikov. (Gompt. rend. Acad. Agric., France, 18, 1932, 201; not Bacterium rubrum Schneider, Arb. bact. Inst. Karlsruhe, 1, Heft 2, 1894, 213.) From the cotton worm (Gelechia gossypiella).

Bacterium salivae Nigula. (Bacillus salivae minutissimus Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 440; Bacterium salivae minutissimus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 86; Nigula, Syst. d. Bakt., 2, 1900, 418.) From secretions of the mouth.

Bacterium salmonicida Lehmann and Neumann. (Baeillus der Forellenseuche, Emmerich and Weibel, Arch. f. Hyg., 21, 1894, 1; Lehmann and Neumann, Bakt. Ding., 1 Aufl., 2, 1896, 240; Die Mikroorganismen, 3 Aufl., 2, 1896, 202; Bacterium salmonica Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 90; see Mackie et al., Final Rept. of the Fruncaulosis Committee, II. M. Stationery Office, Edinburgh, 1935, and Duff, Jour. Bact., 34, 1937, 49.) Pathogenie for trout.

Bacterium sanguinis Migula, (Baeillus sanguinis typhi Sternberg, Man of Bact, 1803, 732; Bacterium sanguinis typhi Chester, Ann. Rept. Del. Col. Agr. Exp Sta., 9, 1807, 89; Migula, Syst. d. Bakt., 2, 1900, 506) From the blood of typhis fever patients.

Bacterium schüffneri Honing (Cent f. Bakt., II Abt , 37, 1913, 370) From tobacco plants in Sumatra.

Bacterium septentrionale Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian) Petrograd, 1914, 239.) From sea water

Bacterium (Proteus) septicus (Babes) Chester. (Proteus septicus Babes, Septische Processe des Kindesalters, 1889; Bacillus proteus septicus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 279; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 102; Bacillus septicus Chester, Man. Determ. Bact., 1901, 245; not Bacillus septicus Macé, Traité pratique de Bact., 1st ed., 1839, 455; not Bacillus septicus Migula, Syst. d. Bakt., 2, 1900, 646; not Bacillus septicus Crookshank, Textb. of Bact., 4th ed., 1900, 632) From the intestine of a child having septicemia.

Bacterium selosum Henrici. (Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 46.) From cheese.

Bacterium siccum Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian), Petrograd, 1914, 235.) From sea water.

Bacterium sieberti Migula. (Siebert, Inaug. Diss., Würzburg, 1894, 13; Migula, Syst. d. Bakt., 2, 1900, 456.) From hair follicles.

Bacterium soriferum Migula. (Severin, Cent. f. Bakt., II Abt., 1, 1895, 799; Migula, Syst. d. Bakt., 2, 1900, 433.) From manure.

Bacterium spiniferum (Unna-Tommasoli) Chester. (Bacillus spiniferus Unna-Tommasoli, Monatsh. f. prakt. Dermatol., 9, 1889, 58; Chester, Ann. Rept Del Col. Agr. Evp. Sta., 9, 1897, 110 and 143) From human skin with soliotrheic eczema.

Bacterium spinosum Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 219) From fermenting beets.

Bacterium spirale Issatchenko. (Recherches sur les microbes de l'Océan Glacial Arctique (in Russian). Petrograd, 1914, 238.) From sea water.

Bacterium sputigenum Chester. (Bacillus aerogenes sputigenus capsulatus Herla, Archiv de Biol., 14, 1895, 403; Chester, Man. Doterm Bact., 1901, 133; not Bacterium sputigenum Migula, Syst. d. Bakt., 2, 1900, 378.) From the blood of a mouse which had been inoculated

From the mouth.

Bacterium squamatum Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 242.) From vegetable infusions.

Racterium sauamosum Kern (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1897, 436 ) From the stomachs and intestines of birds.

Bacterium stalactitigenes Honing (Cent f. Bakt., II Abt , 37, 1913. 375.) From tobacco plants in Sumatra

Bacterium sternbergii Migula. (Bacillus angerobius liquefaciens Sternberg. Man of Bact , 1893, 693, Migula, Syst d. Bakt., 2, 1900, 444; Bacterium anaerobicum Chester, Man. Determ Bact , 1901. 198; Bacillus sternbergii Winslow. Kligler and Rothberg, Jour Baet . 4, 1919, 487.) From intestines of yellow fever cadavers.

Bacterium steroidiclasium Arnaudi and Ercoli, (Boll Sez. ital Soc. intern. Microbiol , 20 (3), 1941, 000, also see Arnaudi, Cent. f. Bakt , II Abt , 105, 1942-43, 352) Source not given in second paper. From bakers' yeast

Bacterium streekers (Trevisan) Migula (Bacillus citreus cadareris Strassmann and Streeker, Ztschr. f. Medizinalbeamte, 1888, No. 3. Bacillus streckers Trevisan, I generi e le specie delle Batteriacee, 1889, 17; Bacterium eitreus cadateris Chester, Ann. Rept Del Col. Agr. Evp. Sta., 9, 1897, 108, Migula, Syst d. Bakt., 2, 1900, 460; Bactersum citreum Chester, Man. Determ. Bact , 1901, 167) From a cadaver.

Bocterium subcitricum Weiss, (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 257) From vegetable infusions

Bacterium subfuseum Kern. (Arb bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 461) From the intestines of birds

Bacterium subluteum Migula. (Bacillus luteus von Dobrzyniccki, Cent f. Bakt., I Abt., 21, 1897, 835; Migula, Syst d Bakt., 2, 1900, 456 ) From the mouth.

Bacterium gulfureum Holschewnikoff. (Helschewnikoff, Fortschr d. Med., 7, 1889, 201 and Ann. de Microgr., 1, 1889-1889, 261; Bacillus sulfureus Trevisan, I

generi e le specie delle Batteriacee, 1889.

17.) From sewage.

Bacterium sumairanum Honing. (Cent. f. Bakt., II Abt., 57, 1913, 374.) From tobacco plants in Sumatra.

Bacterium surgeri (Dornic and Daire) Buchanan and Hammer. (Bacillus surgeri Dornic and Daire, Bull. mens. de l'Office de renseignements agricoles, 6. 1907, 146, Buchanan and Hammer, Iowa Sta Coll Agr. Exp. Sta. Res. Bull. 22, 1915, 254) From serum produced in the manufacture of casein. Causes slimy milk. Closely related to the Bacterium bulgaricum group, according to Buchanan and Hammer.

Bacterium sucosiferum Migula. (Bacillus sucosiferus foctides Unna-Tommasoli, Monatsh f. prakt Dermatol., 8, 1889, 183: Migula, Syst. d. Bakt. 2. 1900, 385) From the beard of a patient with bacillogeme sycosis.

Bacterium syphilidis (Kruse) Migula. (Syphilisbacillus, Lustgarten, Wiener med. Wochnschr, 1884 and Wiener med Jahrbücher, 1885, Pacinia syphilitica Trevisan, I generi e le specie delle Batteriacce, 1889, 23, Bacillus syphilidis Kruse, in Plügge, Die Mikroorganismen. 3 Aufl , 2, 1896, 514; Migula, Syst. d. Bakt . 2, 1900, 496 ) From syphilis.

tachytonum Tischer. Bacterium (Fischer, Deutsche med Wochnschr., 1894. No. 25-28: Bacillus tachutonus Migula, Syst d Bakt, 2, 1900, 655) From feces in a case of cholera.

Bacterium tenue Migula, (Bacillus tenuts sputigenes Pansini, Arch f. path. Anat . 122, 1890, 453, Bacillus sputigenus tenus (sic) Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 431; Bacterium sputigenes tenuis Chester, Ann. Rept Del. Col Agr Exp Sta , 9, 1897, 89, Migula, Syst d Bakt , 2, 1900, 457.) Associated with advanced phthisis and catarrhal pneumonia.

Bacterium termo (Mueller) Ehrenberg. (Monas termo Mueller, Infusoria, 1786; Ehrenberg, Abhandl. Akad. Berl., 1830, Palmella infusionum Ehrenberg, Infusionsthierchen, 1839, 526; Zoogloea termo Cohn, Nova Acta Leop. Carol., 24, 1853, 123; Bacillus termo Trevisan, I generi e le specie delle Batteriacce, 1889; 18.) From infusions.

Bacterum termo var. subterraneum Hansgirg. (Hansgirg, Oest. Bot. Ztschr., 1888, 6; quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1025.) From damp walls in a cellar.

Bacteriumthiogenes Lehmann. (Thionsaurebakterien, Trautwein, Cent. Bakt., II Abt., 63, 1921, 513; tbid., 61. 1924, 1; Lehmann, in Lehmann and Neumann, Bakt. Diag , 7th Aufl., 2, 1927, 516; Thiobacillus trautweinii Bergey et al., Manual, 2nd ed., 1925, 39.) From canal water, sewage and soil. Regarded by Trautwein (loc. cit., 1924, 5) as closely related to Bacterium denstrificans Lehmann and Neumann. See Flavobacterium denstrificans Bergev et al. Heterotrophic and therefore wrongly placed in Thiobacillus (Starkey, Jour. Bact., 28, 1934, 387; Jour. Gen. Physiol., 18, 1935, 325).

Bacterium tholoeideum Gessner, (Gessner, Arch. f. Hyg., 9, 1889, 129; Bacillus tholoeideus DeToni and Trevisan, in Sacearda, Sylloge Fungorum, 8, 1889, 932.) From the human duodenum.

Bacterium tortuosum Zukal. (Zukal, Verh. d. zoolog botan. Gesellsch., Wien, 55, 1855; Bacillus tortuosus Trevssan, I generie ele specie delle Batteriacee, 1859, 18, not Bacillus tortuosus Debono, Cent f. Bakt., I Abt, Orig, 62, 1912, 233) From muddy water

Bacterium tremulans Ehrenberg Ehrenberg, Abhandlungen d Berliner Akad., 1830, 38, Vibrio tremulans Ehrenberg, Die Infusionsthierehen, 1838, 79, Trevisan, Rend. Ist Lomb, 1879, 195, Bacillus tremulans Trevisan, I generi e le specie delle Batteriacce, 1859, 18) From stagnant water, infusions, etc.

Bacterium trichorrhexidis Migula. (Bacillus multiformis trichorrhexidis Hodara, Monatsh. f. prakt. Dermatol., 19, 1894, 173; Migula, Syst. d. Bakt., 2, 1900, 437.) From healthy hair showing trichorrhexis.

Bacterium truncatum Chester. (Bacillus No. XII, Adamett, Landwittsch, Jahrb., 18, 1859; Chester, Man. Determ. Bact., 1901, 187; not Bacterium truncatum Migula, Syst. d. Bakt., 2, 1909, 407; not Bacterium truncatum Chester, loc. ci., 195.) From Emmenthal cheese.

Bacterium tuberosum Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1896, 455, Bacillus tuberosus Nepveux, Thèse, Fac Pharm., Paris, 1920, 113) From the intestines of birds.

Bacterium turcosum. (Quoted from Franke and Rudloff, Biochem. Ztschr., \$10, 1942, 207.) Source not given.

Bacterium uniforme Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 250) From fermenting malt.

Bacterium ureae Leube and Graser, (Leube and Graser, Arch. f. pathol. Anat. u. Physiol., 100, 1885, 555; Bacillus ureae Dyar, Ann. N. Y. Acad. Sci., 8, 1895, 357; not Bacillus ureae Miquel, Bull. Soc. Chin. d. Paris, 31, 1879, 391.

12,635; Cent. ocamobacterium ureae Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 78 ) From urine. Leube makes no statement regarding spore forma-While Miquel's and Leube's ortion ganisms are sometimes regarded as having been identical. Miquel did not regard his Bacillus urgae as being identical with Leube's Bacterium ureae and gave them separate names Urobacillus duclauxu and Urobacillus leubei (Miquel and Cambier, loc. cit., 631 and 635). The latter name had however been previously used by Beiterinck (loc. cit.) for a different organism. Dyar credits the name Bacillus ureae to Jaksch (Ztschr. physiol Chem , δ, 1881, 395) nbo, however, spoke only of a Harnstoffpilz and evidently had no pure cultures Dyar's culture which came from Krdl is listed in the 1900 Král catalogue as

Bacillus ureae Leube. Also see Gibson (Jour. Bact., 24, 1935, 493). Löhnis (Handb. f. landwirtsch. Bakt., 1910, 459) thinks that this species belongs in the Proteus group.

Bacterium vaillardi Migula. (Kelseh and Vaillard, Ann. Inst. Past., 4, 1890, 276, Migula, Syst. d. Bakt., 2, 1900, 137.) Found in swellings of the lymph system in leukemia.

Basterium taricaum Migult. (Gombert, Becherches expér, merobes conjonetives, Parie, 1899; Bacullus varierosus conjunctura Stermberg, M.n. of Bret, 1897, 471; Bacterium traveous conjunctivae Chester, Ann Rept. Del Col Ar-Exp. Sta. 9, 1897, 100; Miguls, Syst d Bakt, 2, 1900, 441). From the normal conjunctiva of man

Bacterium variosum Weiss (Arb bakt Inst. Karlsruhe, 2, Heft 3, 1902, 218) From vegetable infusions

Bacterium relatum Migula. (Bacullus tuberigenus 5, Gonnermann, Landwirtsch, Jahrb., 25, 1894, 657, Migula, Syst. d. Bakt. 2, 1900, 454, Bacullus relatus Nepveux, Thèse, Fac. Plantin, Paris, 1920, 113) From Iupine root nodules

Bacterium vernicosum Zopf (Zopf, Beitr, z. Physiol u. Morphol, mederer Organismen, Heft 1, 1802, 63, Bacillus vernicosus Migula, Syst. d. Bakt., 2, 1900, 781.) From cotton-seed meal

Bacterium resiculosum Henrici (Arb a. d. bakt. Inst. d. techn. Hochschule zu Karlsruhe, 1, Heft, 1, 1891, 37.) From cheese

Bacterium villosum (Keck) Migula (Bacillus villosus Keck, Inaug Drvs, Dorpit, 1890, 47; Migula, Syst d. Bakt, 2, 1990, 429, Pleomobacterium villosum Pribram, Klassifikation der Schizomyecten, Leipzig und Wien, 1973, 79) From water

Bacterium vinicola Migula (Bacillus viscosis iini Kramer, Bakteriol, in ihren Beziehungen z. Landwittsch, 2, 1892, 144, Migula, Syst. d. Bakt., 2, 1990, 510) From wine.

Bacterium tinsperda Migula (Bacil-

lus saprogenes vini IV, Kramer, Bakteriol, in ihren Beziehungen z. Landwirtsch., 2, 1892, 135; Migula, Syst. d. Bakt., 2, 1900, 446) From diseased wine, Bacterium viride van Tieghem. (Bull.

Bacterium rivide van Tieghem. (Bull. Soc. bot. France, 27, 1880, 174.) Found on a fungus.

Bacterium riscidum Migula. (Bacillus risconis margarineus Jolles and Winkler, Zischr. f. Hyg., 20, 1895, 101; Migula, Syst. d. Bakt., 2, 1900, 450.) From margaine.

Racterium viscosum Miguls (Hacillus viscosus sacchari Kramer, Sitzungsb. dd kais, Akad. d. Wiss., Wien, 1889; Bakterol. in thren Beziehungen z. Landwirtsch. 2, 1892, 166; Migula, Syst. d Bakt., 2, 1800, 447.) Samilar to Leuconostoc mesenteroides except that it houcefus calciain

Bacterium viscosum non liquefaciens Statter and Wsorow (Cent. f. Bakt., II Abt., 71, 1927, 117.) From puppe of moth (Euroa segetum). Resembles Bacillus viscosus Frankland.

Bacterium ritulinum Chester. (Bacillus der Septikämie bei einem Seekalbe, Bosso, Cent. f. Bakt., 25, 1899, 52; Chester, Man. Determ. Bact., 1901, 113) From a septicemia of the sea-calf (Phocaritulinu)

Bacterium ritulorum Migula, (Bacilius der aussen Rühr der Kälker, Jensen, Monatah, f. prakt. Tierheilk., 5, 1892, 92; Maanedakrift for Dyrlveger, 4, 1892–89, 140, Bactillus dysenteriae ritulorum Kruse, in I lügge, Die Mikroorgunismen, 3 Aufl., 2, 1896, 412; Racterium dysenteriae ritulorum Chester, Ann. Rept. Del. Col. Agr. Exp. Sts., 9, 1897, 86, Migula, 5yst. d. Bakt., 2, 1900, 391; Bacterium dysenteriae Cluster, Man. Determ. Bact., 1901, 145 j. Associated with dysentery of calves

Bacterium winkleri Migula. (Margarinhaeillus \( \textit{\textit{B}}, \) Jolles and Winkler, Ztschr \( f \) Hyg, \( 20, \) 1895, 102, Migula, Syst \( d \) Bakt \( , 2, \) 1900, 485 \( ) From margarine

Bacterium wrightii Chester (Capsule Bacillus of Mullory and Wright, Z'schr. f. Hyg., 20, 1895, 220; Chester, Man. Determ. Bact., 1901, 133.) From a case of bronchopneumonia.

Bacterium zinnioides Honing. (Cent. f. Bakt., II Abt., 37, 1913, 371.) From tobacco, peanut and other plants in Sumatra.

Bacterium zuernianum (List) Chester. (Bacillus zuernianua List, Inaug. Diss, Leipzig, 1885, 36; Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 83) From fresh manure and intestines of sheep, also found in water.

Coccobacillus aeridiorum Picard and Blanc. (Coccobacille des sauterelles, d'Herelle, Compt. rend. Acad. Sci. Paris, 152, 1911, 1413; Picard and Blanc, that, 156, 1913, 1335; Bacillus aeridiorum Chatton, that, 156, 1913, 1708.) From a locust (Schistocerca americana Drury)

Coccobacillus cajae Picard and Blanc. (Compt. rend. Acad Sci., Paris, 168, 1913, 1334; Bacillus cajus Marchol, Revue de Phytopath Appl, 1, 1914, 11.) From diseased cateroillars of Arctia caja.

Coccobacillus gibsoni Chorine. (Internat Corn Borer Invest., Sci. Repts, 2, 1029, 42; B gibsoni Paillot, B presumably indicates Bacterium, see index, p. 522, L'infection chez les insectes, 1933, 134; Bacillus gibsons Steinhaus, Bacteria Associated Extracellularly with Insects, Minneapolis, 1942, 58.) From diseased corn borer larvae (Pyraustra nubilalis).

Coccobacillus insectorum Hollande and Vernier. (Compt rend Acad. Sci., Paris, 171, 1920, 207.) From diseased eaterpillars of a moth (Malacosoma castrensis).

Coccobacillus insectorum var malacosomae Hollande and Vernier (Compt. rend. Acad. Sci., Parıs, 171, 1920, 208.) From diseased caterpillars of a moth (Malacosoma castrensis). Dentrobacterum thermophilum Am-

broz. (Cent. f. Bakt., II Abt., 37, 1913, 3.) A thermophilic bacterium from soil. Diplobacillus melolonihae Paillot. (Compt rend. Soc Biol., Paris, 69, 1917, 5:Annales des Épiphyties, 8, 1922, 117.) From larvae of cockchafers (Melolontha melolontha).

Diplobacillus pieris Paillot. (Annales des Épiphytics, 8, 1922, 129.) From discased caterpillars of the cabbage butterfly (Pieris brassicae).

Helicobacterium aerogenes Miller. (Deutsche Med, Wehnschr., 12, 1886, 119; Bacillus helicoides De Toni and Trevisan, in Saecardo, Sylloge Fungorum, 8, 1889, 952) From the stomach. This is the type species of the genus Helicobacterium.

Helicobacterium Mebsii Miller. (Dre Mikroorganismen der Mundhöhle, 2 Aufl, Leipzig, 1892, 370; quoted from Buchanan, Gen. Syst. Bact., Baltimore, 1925, 327) From the mouth.

Microbacillus cutreus baregensis Robne and Hauduroy. (Compt. rend Soc. Bol., Paris, 93, 1928, 26.) From hot sulfur springs at Barèges. Fourment (Compt rend. Soc. Biol., Paris, 93, 1928, 58) states that this species is Bacullus lutes Flugge, but Robine and Hauduroy (Compt. rend Soc. Biol., Paris, 99, 1928, 317) deny this.

Micrococcobacillus necroticans Pascheff. (See Pascheff, Bericht. d. ophthalmol Gesellsch., Heidelberg, 1916, 418 or Klin Monatsbl. f. Augenheilk, 57, 1916, 517 and 58, 1917, 97, Goccobacilus polymor phus necroticans, quoted from Bayer and v Herrenschwand, Arch. I Ophthalmol, 98, 1919, 358, Micrococcobacillus polymor phus necroticans Pascheff, Arch. d'Ophthalmol, 28, 1921, 28; Pascheff, ibid, 97.) From the human eye. Reported as the causal organism of conjunctivitis

Nitrosobacillus thermophilus Campbell (Sci , 75, 1932, 23.) From soil. Oxidizes ammonia to nitrite.

Pacinia ferrarii Trevisan. (Bacillo dell' ulcera molle, Ferrari, 1885; Trevisan, I generi e le specie delle Batteriacce, 1889, 23.)

Pacinia fickii Trevisan (Bacillus e des Conjunctivalsackes, Fick, 1887; Trevisan, I generi e le specie delle Batteriacce, 1889, 23.) Pacinia micheli Trevisan (Michel, Luftstäbehen des Conjunctivalsecretes, 1882; Trevisan, I generi e le specie delle Batteriacce, 1889, 23) From the conjunctiva

Plocamobucterium acid lactici Pribram. (Lange Milehsuurestlichen, Wolff, Cent f Bakt, II Abt., 20, 1935, 515, Pribram, Klassifikation der Schiromyceten, Leipzig und Wien, 1933, 76) From milk.

Plocamobacterium epidermidis (Bizzozero) Pribram (Leptothriz epidermidis Bizzozero, Arch f. path Anat, 98, 1896, 485, Pribram, loc est, 77) From the skin

Plocamobacterium proteolyticum (Wollman) Pribram (Glycobacter proteolytteus Wollman, Ann Inst Past , 26, 1912, 617, Pribram, loc ett , 118)

Plocamobacterium rubrum Pribram, loc cit, 78 Red cheese hacterium (Kiel)

Plocamobacterium tilsitense Pribram, loc cit, 78. From Tilsit cheese (Kiel)

Proteus hominis Bordoni-Uffreduzzi (Riseterium, Bordoni-Uffreduzzi and Di Mattei, Arch per le scienze mediche, 10, 1880, No 7; abst. in Cent. I. Bakt. 1, 1887, 315, Bordoni-Uffreduzzi, Zitschr I Hyg. 4, 1883, 333, Proteus hominis capsulatus Bordoni-Uffreduzzi, zibid. Proteus capsulatus septicus Banti, Lo Spermentale, 83; Kebsella bordoni Trevisan, I gener i e le specie delle Butteriace, 1883, 25, Bacillus capsulatus septicus Kruse, in Tiugge, Die Mikroorganismen, 3 Aufl. 2, 1806, 315, Bacierum hominis capsulatus Chester, Ann. Rept. Del Col Agr. Lup Sta. 9, 1887, 1365, Bacterum hominis capsulatus Chester, Ann. Rept. Del Col Agr. Lup Sta. 9, 1887, 1365, Bacterum hominis capsulatus Chester, Ann. Rept. Del Col Agr. Lup Sta. 9, 1887, 1365, Bacterum hominis capsulatus Chester, Ann. Rept. Del Col Agr.

latus and Bacterium capsulatus septicus Chester, tidi., 130; Bacterium proleus Migula, Syst. d. Bakt., 2, 1900, 362, Bacterium bordonii Chester, Manual of Determ Bact., 1901, 182.) From a cess of rappicker's disease which may have been anthray or malignant edema

Urobacillus beijerinekii Christensen. (Christensen, Cent. f. Bakt., II Abt., 27, 1910, 357; Bacillus beijerinekii De Rossen, Mierobiologia Agraria e Technica, 1927, 646) Prom humus. Utihzes urev.

Urobacillus jalschii Söhngen. (Söhngen, Cent f. Bakt, JI Abt., 23, 1909, 93 Bacillus jalschii De Rossi, Microbiologia Agraria e Technica, 1927, 646 ) From garden earth Utilizes urea.

Urobacillus miquelii Beijerinek, (Cent. f Bakt, 7, 1901, 47) From garden carth Löhnus (Handb. f landwirtsch. Bakt, 1910, 459) regards this as belonging to the genus Proteus

Urobacillus schülenbergii I and II Muşuel (Miquel, Ann de Mierograph, 5, 1893, 321 and 223; Bacillus schülzenbergii Migula, Syst d Bakt, 2, 1909, 277) From sewage and river water. These my belong to Proteus (Löhnis, Hlandb. f landwirtsch. Bakt., 1910, 459).

Urobacterum acrophilum Rubentschik. (Cent f Bakt, II Abt, 68, 1925, 175.) From salt water, Lake Liman near Odessa

Urobacterium citrophilum Rubentschik. (Cent f Bakt., II Abt , 66, 1925, 172) From black mud and salt water, Lake Liman near Odessa.

Viscobacterium lactis foetidum Lava. (Cent. f Bakt, II Abt., 95, 1936, 130.) From milk having a fetid odor

## APPENDIX TO SUBORDER EUBACTERHNEAE

Record of species and synonyms discovered too late to be entered in the main body of the text. Arranged alphabetically by genera.

Acetobacter aceti (Kittzing) Berjerinck syn. Bacterium aceticus Chester, Ann. Rept. Del. Col. Agr Exp. Sta., 9, 1897, 77.

Acetobacter acetosum Bergey et al. syn. Ulvina acetosa Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75,

Acctobacter ascendens Bergey et al. syn Ulvina ascendens Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75.

Acetobacter diversum Humm. (Duke Univ. Marine Lab , North Carolina, Bull. 3, 1946, 63.) From sea water. Beaufort, North Carolina and marine algae, Miami, Florida. Digests agar.

Acetobacter mobile Tosić and Walker. (Jour of Brewing, 50, 1944, 296.) From bottled ale.

Acetobacter pasteurianum (Hansen) Beijerinck syn Bacillus pasteurianum Flugge, Die Mikroorganismen, 2 Aufl., 1886, 314, not Bacillus pasteurianus Lehmann and Neumann, Bakt, Diag, 4 Aufi , 2, 1907, 82, Ulvina pasteuriana Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76.

Acetobacter potens Humm (Duke Univ. Marine Lab , North Carolina, Bull. 3, 1946, 63.) From intertidal sand, Beautort, North Carolina. Digests agar

Acetobacter rancens Beijerinck syn Ulvina rancens Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76

Acetobacter singulare Humm (Duke Univ. Marine Lab , North Carolina, Bull. 3, 1916, 62) From sea water, Beaufort, North Carolina Digests agar

Acetobacter xylinum (Brown) Holland Bacıllus xylınus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; Ulvina xylina Pribram, Kla ii der Schizomyceten, Leipzig und Wien, 1933, 76.

Achromobacter caseinscum (Jour. Bact., 16, 1928, 38.) From a solution of sodium caseinate. Polar flagellate. Possibly a strain of Pseudomonas fluorescens Migula that had lost the power of forming pigment.

Achromobacter nijibetsui Takeda. (Cent. f. Bakt., II Abt., 94, 1936, 48) From diseased salmon eggs. Not found to be virulent. A polar-flagellated, Gram-negative, yellow chromogen, presumably belonging in the genus Nanthomonas.

Actinobacillus actinomycetemcomitans Topley and Wilson syn. Bacillus actinomycetemcomitans Rosebury, Bact Rev., 8, 1944, 205.

Aerobacter liquefaciens Beijerinch. (Cent f. Bakt., II Abt., 6, 1900, 199; not Aerobacter liquefaciens Grimes and Hennerty, Sci Proc. Roy, Dublin Soc., (N.S.) 20, 1931, 93.) From mud and water in swamps. Monotrichous, otherwise like Aerobacter cloucae This may have been a species of gas-forming Pseudomonas.

Nijdam. Aerobacter farfarmorum. (Thesis, Leiden, 1907.) Decomposes didentical with tartrates Probably Aerobacter aerogenes (Vaughn, Marsh, Stadtman and Cantino, Jour. Bact , 52, 1946, 324)

Alcaligenes marshallis Bergey et al. syn Bacterium marshalli Buchanan and Hammer, Iona Sta Coll Agr. Exp Sta., Res. Bull. 22, 1915, 272.

Alcaligenes viscosum Weldin syn Plocamobactersum risensum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 79.

Ascococcus buccalis Miller. (Die Mikroorganismen der Mundhöhle, Leipzig,

7, 65) From the mouth.

Bacillus annulatus Wright Syn. Bacterium annulatus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 105

Bacillus cubonianus Macchiati syn Bacterium cubonianus Chester, Ann. Rept Del Col. Agr Exp. Sta , 9, 1897, 132

Bacıllus duplicatus Wright (Wright, Mem Nat Acad. Sci., 7, 1895, 457; Bacterium duplicatus Chester, Ann Rept Del Col Agr Exp. Sta., 9, 1897, 90) From Schuylkill River water. Monetrichous

Bacıllus fivorescens mutabilis Wright (Wright, Mem Nat Acad, Sci., 7, 1895, 449, Bacterium fivorescens mutabilis Chester, Ann. Rept. Del Col Agr. Exp Sta., 9, 1897, 120) From Schuylkill River water.

Bacillus fluorescens nivalis Eisenberg syn. Bacterium fluorescens nivalis Chester, Ann Rept Del Col Agr. Exp Sta, 9, 1807, 120.

Bacillus hayducki Henneberg syn Plocamobacterium hayducki Pribram, Klassifikation der Schizomyceten, Leipzig und Wien. 1933. 77.

Bacillus influenzoides apis White (Jour Path and Bact, 24, 1921, 71) From intestine of bee Monotrichous Bacillus mesentericus aureus Winkler

syn Bacillus uinkleri Chester, Man Determ Bact, 1901, 256

Bacillus pabuli acidi II Weiss svn Plocamobacterium pabuli Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 78

Bacillus taginae Kruse syn Bacterium taginae Chester, Ann Rept Del Col Agr Exp Sta, 9, 1897, 67

Bacillus trudi-luteus Trevisan (Grungelber Bacillus, Escenberg, Bakt. Diag, 1 Aufl., 1886, 10, Trevisan, I generic le apocie delle Batternaces, 1889, 19) From water. This probably was the same as Bacillus fluorescens Trevisan, ibid, 19 and Pseudomonus fluorescens Migula Bacillus wortmannii Henneberg syn. Plocamobacterium wortmanni Pribram, Klassifikation der Schizomyceten, Leipzig und Wien. 1933, 79.

Bacterium granulosum Lehmann and Neumann syn. Plocamobacterium granulosum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 77

Bacterium lipolyticum Huss syn. Kurthia lipolyticum Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75

Bacterium orleanense Henneberg syn. Ulvina orleanensis Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75

Bacterium zylinoides Henneberg syn Ulvina zylinoides Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 76.

Brucella byzantinea (Montsouris) Pribram (Coccobacterium byzantineum Montsouris, quoted from Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 67, Pribram, idem.)

Brucella cocciformis (Jaiser) Pribram. (Bacterium cocciforme Jaiser, quoted from Pribram, Klassifikation der Schizomyceten, 1933, 67, Coccobacterium thermophilum Negre, Compt. rend. Soc. Biol, Paris, 75, 1913, 814 and 867; Pribram, idem) From sputum

Chlorobacterium lactis Guillebeau (Landw Jahrb. d. Schweiz , 4, 1809, 32) From the udder of cows with mastitis Produces a green pigment Presumably identical with Pseudomonos aeruginosa Migula The type species of the genus Chlorobacterium Guillebeau

Chromobacterium chocolalium Knutsen (Quoted from Lasseur, Dupaiv-Lasseur and Meleion, Travauv du Lab de Microbol, Fac Pharm de Nancy, Fasc XIII, 1912-3-41, 1944, 164, 187, 293, and 313 Joolated by M. H. Knutsen, State Coll., Pennsylvania Source not known Dull violet with brown tinge. Disso-

ciates into a violet and an orange strain (Chromobacterium orangium Knutsen, loc. cit., 294).

Chromobacterium iodinum Davis. (Davis, Cent. f. Bakt., II Abt., 160, 1939, 273; also see Clemo and McIlwain, Jour. Chem. Soc., I't. 1, 1933, 479; I'seudomonas iodinum Tobie and Pseudomonas etemo Tobie, Bull. Assoc. des Diplômés de Microbiol., Fac. Pharm. Nancy, No. 18, 1939, 16.) From plate inoculated with milk. This non-motile organism does not have the characters of Chromobacterium seusu stricto so that this species is retained with Bacterium for the present.

Coccus cumulus minor Black. (Trans, Ill. State Dental Soc., 23, 1886, 192.) From the mouth.

Corynebacterium hemolyticum Mac-Lean, Liebow and Rosenberg. (Jour. Inf. Dis., 79, 1946, 69.) From infections among American soldiers and natives in the South and West Pacific. Similar in many ways to Corynebacterium pyogenes and C. ovis.

Corynchaeterium piriforme Honing. (Cent. f. Bakt , II Abt., 37, 1913, 383.) From tobacco plants in Sumatra.

Diplococcus aquatilis Vaughan. (Amer. Jour. Med. Sci., 104, 1892, 184.) From water.

Diplococcus glycinephilus Cardon and Barker. (Jour Bact, 52, 1916, 629) From marine mud

Diplococcus Inteus Adametz and Wichmann (Adametz and Wichmann, Die Bakterien der Trink- und Nutzwässer, Mitt. Oest Versuchsstat. f Brauerei u. Mälterei, Heft. 1, 1888, 49, Planococcus Inteus Migula, Syst. Bakt. 2, 1900, 274) From water.

Escherichia Castellani and Chalmers syn Colibacter Pestana and Andrade, Ann Paulistas de Med e Cir, 59, 1910, 462.

Excherichia coli Castellani and Chalmers syn. Colibacter commune Pestans and Andrade, loc. cit

Flavobacterium harrisonis Bergey et al

syn. Bacillus harrisonii Buchanan and Hammer, Iowa Sta. Coll. Agr. Exp Sta., Res. Bull. 22, 1915, 257.

Flavobacterium tabidum Kimata, (Cent. f. Bakt., II Abt., 105, 1942, 120) From spoiled semi-dried fish (Trachurus japonicus). Polar flagellate.

Fusiformis grandis Grassé. (Compt. rend. Soc. Biol., Paris, 94, 1925, 101; Arch. Zool. Expér. et Gén., 65, 1926, 463.) From the surface of the body of a flagellate (Polymastux melolonthae), in the intestine of larvae of beetles and tipulids, possibly also free in the intestine of the insects.

Tusiformis legeri Grassé. (Compt. rend. Soc. Biol., Paris, 94, 1926, 1014, Arch. Zool. Expér. et Gén., 65, 1926, 467.) From the surface of the body of a flagellate (Polymanix legeri) and in the intestine of diplopods.

Fusiformis lophomonadis Grasse. (Compt. rend. Soc. Biol., Paris, 91, 926, 1015; Arch. Zool. Exper. et Gen, 05, 1926, 468.) Trom the surface of the body of a flagellate (Lophomonas siriat) and in the intestine of cockracthres.

Fusiformis melolonthae Grasse (Compt. rend. Soc. Biol., Paris, 24, 1926, 1014; Arch. Zool. Uxpfr. et Gén., 65, 1926, 465.) From the surface of the body of a flagellate (Polymantic melolonthae) and in the intestine of larvae of levetles and tipulids.

Gluconoacelobacter cerinus Takahashi and Asai. (Cent. 1. Bakt., II Abt., 93, 1936, 252.) From fruits

Gluconoactobacter liquefaciens Takahashi and Asai, loc. cit. From fruits. Gluconoactobacter roscus Takah-sahi and Asai. (Bacterium industrium Asr. hoshigaki Takahashi and Asai, Cent. f. Bakt. JI Abt., 82, 1930, 490; Bacterium hoshigaki var. glucuronicum I Takahashi and Asai, ibid., 63, 1933, 282; Takahashi and Asai, ibid., 63, 1936, 282) From dried persimmons (hoshigahi).

Gluconobacter liquefaciens And (Jour Agr Chem Soc. Japan, 19, 1931,

621 and 11, 1935, 50, see Cent f. Bakt., II Abt., 93, 1936, 248.) From fruits

Jodococcus magnus Miller. (Deutsche med Wehnschr., 14, 1888, 612.) From the mouth. The type species of the genus Jodococcus (syn. Iodococcus) Miller

Jodococcus partus Miller (ibid , 612) From the mouth.

Lactobacillus bulgaricus Holland syn Bacterium bulgaricum Buchanan and Hammer, Iowa Sta, Agr Evp Sta., Res. Bull. 22, 1915, 250.

Lactobacillus buchneri Hergey et al. syn Ulvina buchneri Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 75.

Lactobacillus delbrueckii Benjerinek syn Ulvina delbruecki Pribram, loc. est, 75, Plocamobacterium delbruecki Pribram, ibid., 77.

Lactobacillus helveticus Holland syn Plocamobacterium casci Pribram, loc. cit, 77; Plocamobacterium helveticum Pribram, ibid., 78.

Lactobacillus pastorianus Bergey et al. syn. Plocamobacterium pastorianum Pribram. loc. cit... 78

Lactobacillus pentoaceticus Fred, Peterson and Davenport syn Plocamobacterium pentoaceticum Pribram, loc. cit. 78.

Lactobacillus plantarum Holland syn Ulvina cucumeris fermentati Pribram, loc cit., 75.

Lactobacillus taette Olsen-Sopp. (Cent. f Bakt, II Abt, 33, 1912, 14) From ropy milk

Leptotrichia Trevisan partial syn Leucothrix Oersted, De regionibus

marinis, 1844, 44.

Listeria monocytogenes Pirie syn. Brucella monocytogenes Pribram, Klassifikation der Schizomyceten. Leipzig und

Wien, 1933, 68

Mammecoccus gorini (Quoted from L. Gorini, Enzymologia, 10, 1912, 102)
From the udder

Micrococcus afermentans Castellani (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536; also see Jour. Trop Med. and Hyg, 55, 1932, 372) From an ulcerative lesion of the skin

Micrococcus albus var. maltigenes Dumais and Albert. (Quebec Laitier, 5 (2), 1946, 19.) From Richelieu cheese Regarded as an important ripening agent

Micrococcus aquatilis Vaughan. (Vaughan, Amer. Jour. Med. Sci., 104, 1892, 190; not Micrococcus aquatilis Chester, Man Determ Bact, 1901, 88; not Micrococcus aquatilis Bolton, Zischr. f. Hye. J. 1886, 44). From water.

Micrococcus aquatilis albissimus von Rigler. (Hyg Rund, 12, 1902, 482) From bottled mineral waters

Micrococcus aquatilis albus Vaughan. (Vaughan, Amer. Jour. Med. Sei, 104, 1892, 182; not Micrococcus aquatilis albus Toporoff, Cent f Bakt, 15, 1893, 487.) From water.

Micrococcus aquatilis magnus Vaughan (Amer Jour Med Sci , 104, 1892, 182.) From water

Micrococcus aquivivus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 275) From sea water

Micrococcus cyaneus (Schroeter) Cohn syn Bacterium cyaneus White, U. S D.A., Bur. Entomol Tech Ser. Bull. 14, 1906, 16.

Micrococcus enteroideus Castellani (Proc. Soc Exp Biol. and Med , 25, 1928, 536, also see Jour. Trop. Med and Hyg., 35, 1932, 372.) From feces.

Micrococcus suryhalis ZoBell and Up ham. (Bull. Scripps Inst. of Oceanography, Univ. Cahf., δ, 1944, 255) From sea water

Micrococcus griseus Winter syn. Bacillus griseus Trevisan, I generi e le specie delle Batteriacee, 1889, 18.

Micrococcus himonoi Kimata. (Cent f Balt, II Abt, 105, 1912, 116) From spouled semi-dried fishes (Scomber japonicus and Trachurus japonicus) Resembles Micrococcus caseolyticus and M mucofaciens. Micrococcus infimus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 262.) From marine bottom deposits.

Micrococcus Iaevulosinertis Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536; also see Jour. Trop Med. and Hyg., 55, 1932, 372.) From a case of stomatitis.

Micrococcus maripuniceus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1914, 261.) Sessile form found on slides submerged in sea water.

Micrococcus metentericus Castellani. (Quoted from Jour. Trop Med. and Hyg., 35, 1932, 372.) From case of ulcerative colitis.

Micrococcus moricolor Holmes and Wilson. (Jour. Bact., 40, 1945, 311.) From contaminated wounds. Produces a mulberry pigment on potato

Micrococcus myceticus Castellani, (Arch, Dermat. and Syphil., 18, 1928, 857.) From cases of pseudomycosis.

Micrococcus nexifer Miller. (Killer, Die Mikroorganismen der Mundhöhle, Leipzig, 1889, 65.) From the mouth, Probably Streptococcus brews according to Goadby (Mycology of the Mouth, London, 1903, 60).

Micrococcus pulatus Ravenel (Mem. Nat Acad. Sci. 8, 1896, 21.) From soil. Micrococcus pulmets Castellani. (Quoted from Jour. Trop. Med and Hyg., 35, 1932, 372.) From a case of glossitis.

Micrococcus rhodochrous Migula syn. Bacillus rhodochrous Dyar, Ann. N. Y. Acad. Sci. 8, 1895, 362, Bacterium rhodochrous Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 116) Dyar had the original Micrococcus rhodochrous culture from Kral and felt as have others who have examined this culture that it is not a true Micrococcus.

Micrococcus sedentarius ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 260) Sessile form found on slides submerged in sea water.

Micrococcus sedimenteus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calli., 5, 1944, 265.) Sessile form found on slides submerged in sea water and in marine mud.

Micrococcus visicidus Castellani, (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536; also see Jour. Trop. Med. and Hyg., 35, 1932, 372.) From an inflamed upper lip.

Microspira racillans Gicklhorn. (Cent. I. Bakt., II Abt., 50, 1920, 422.) From the pool in the Botanical Garden, Univ. Graz, Austria. Contains grains of sulfur.

Neisseria babesi Trevisan. (Bactérie de l'hémoglobinurie du boeuf, Babes, 1888; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria lutea (Adametz) Trevisan. (Diplococcus luteus Adametz, 1887; Trevisan, I generi e le specie delle Batteriacce, 1883, 32.)

Neisseria micheli Trevisan. (Trachomcoccus, Michel, 1886; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria pharyngis syn. Micrococcus pharyngis Cruikshank and Cruikshank, Med. Res. Council Syst. of Bact., 8, 1931, 349.

Pacinia decipiens Trevisan. (Spirillum aus der Luft, Babes, Zischr. f. Hyg, 5, 1888, 183; Trevisan, I generi e le specie delle Batteriacee, 1889, 24.) From the air.

Pacinia rabida Trevisan. (Spirillum bei Rabies, Babes, Ztschr. f. Hyg., 5, 1888, 181; Trevisan, I generi e le specie delle Batteriacce, 1889, 23)

Pectobacterium delphinii Waldee. (Ark, Phytopath., 28, 1938, 281; Waldee, Iowa State Coll. Jour. Sci., 19, 1945, 471.) Causes larkspur bacterial blight.

Phytomonas asplenii Ark and Tompkins. (Phytopath, \$6, 1946, 760.) Causes leaf blight of bird's nest fern. Phytomonas maculifelium-gardeniae



Micrococcus infimus ZoBell and Upham. (Bull, Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 262.) From marine bottom deposits.

Micrococcus laevulosinertis Castellani. (Proc. Soc. Exp. Biol, and Med., 25, 1928. 536; also see Jour. Trop, Med. and Hyg., 35, 1932, 372.) From a case of stomatitis.

Micrococcus maripuniceus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 264.) Sessile form found on slides submerged in sea water.

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Micrococcus sedimenteus ZoBell and Upham. (Bull, Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 265.) Sessile form found on slides submerged in sea water and in marine mud.

Micrococcus visicidus Castellani. (Proc. Soc. Exp. Biol. and Med., 25, 1928, 536; also see Jour. Trop. Med. and Hyg., 85, 1932, 372.) From an inflamed upper lip.

Microspira vacillans Gicklhorn, (Cent. f. Bakt., II Abt., 50, 1920, 422) From the pool in the Botanical Garden, Univ. Graz, Austria. Contains grains of sulfur.

Neisseria babesi Trevisan. (Bactérie de l'hémoglobinurie du bocuf. Babes. 1888; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria lutea (Adametz) Trevisan. (Diplococcus luteus Adametz, 1887; Trevisan, I generi e le specie delle Batteriacee, 1889, 32.)

Neisseria micheli Trevisan chomcoccus, Michel, 1886; Trevisan, I generi e le specie delle Batteriacee, 1889,

Neisseria pharyngis syn. Micrococcus pharyngis Cruikshank and Cruikshank, Med. Res. Council Syst. of Bact , 8, 1931, 349.

Pacinia decipiens Trevisan. (Spirillum aus der Luft, Babes, Ztschr. f. Hyg, 5, 1888, 183; Trevisan, I generi e le specie delle Batteriacee, 1889, 24) From the

Pacinia rabida Trevisan. (Spirillum bei Rabies, Babes, Ztschr. f. Hyg, 8, 1888, 181; Trevisan, I generi e le specie delle Batteriacce, 1889, 23.)

delphinii Waldee. Pectobacterium (Ark, Phytopath , 28, 1938, 281; Waldee, Iowa State Coli. Jour. Sci., 19, 1945, 471) Causes larkspur bacterial blight.

Phytomonas asplenii Ark and Tomp-(Phytopath., 36, 1916, 760.) Causes leaf blight of bird's nest fern.

maculisclium-gardeniae Phylomonas

Ark. (Phytopath, 35, 1946, 867.) From gardenia (Gardenia jasminoides). A

Phylomonas syringae populans Smith. (Jour. Agr. Res., 68, 1944, 269.) Considered the cause of blister spot, a disease of apple.

Phytomonas washingtoniac Pine. (Phytopath., 35, 1943, 1203) From the Washington palm, Washingtonia filifera. A pseudomonad.

Pneumococcus flatescens Arloing. (Compt. rend. Acad. Sci., 103, 1889, 428 and 459.) From lesions of cattle having peripheumona.

Pneumococcus gutta ceres Arloing, loc. ctt. From lesions of cattle having perinneumonia

Pneumococcus lichnoides Arloing, loc. cit. From lesions of cattle having peripneumonia.

Pseudomonas aestumarina ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 269) A marine sedentary organism.

Pseudomonas allıs (Griffiths) Mıgula syn. Bacillus allis Sternberg, Man of Bact., 1893, 629.

Pseudomonas ambigua (Wright) Chester syn Bacterium ambiguus Chester, Ann Rept. Del Col. Agr Exp. Sta., 9, 1897, 71.

Pseudomonas atlantica Humm. (Duke Univ Marine Lab, North Carolina, Bull 3, 1946, 58.) From seaweed (Gracilaria blodgettri) and beach sand. Digests

Pseudomonas aurea Migula syn. Bacterium fluorescens aureus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 109.

Pseudomonas azotogena ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ. Cahf., 5, 1944, 260) From sea water and marine mud.

Pseudomonas beaufortensis Humm (loc cit, 58). From seawater, bottom mud and on algae Digests agar.

Pseudomonas berolinensis Migula (Indigoblauer Bacillus, Claessen, Cent. f. Bakt., 7, 1890, 13. Bacillus berolinensis indicus Germano, Cent. f. Bakt., 12. 1892. 517: Bacillus indicaferus Zimmermann. Bakt. unserer Trink- u Nutzwässer, Chemnitz, 2, 1894, 16, not indicated as being the same as Bacillus indigoferus Voges, Cent. f. Bakt . 14, 1893. 307 Bacillus indiganaceus Schneider Arb bakt, Inst. Karlsruhe, 1. Heft 2. 1891 228: Migula in Engler and Prantl Die naturi. Pflanzenfam 1. in 1895. 29: Bacterium indigonaceum Lehmann and Neumann, Bakt, Drag. 1 Aufl., 2. 1896, 267: Bacterium berolinensis indicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta . 9, 1897, 118 ) From Spree River water.

Pseudomonas butyri Migula syn. Bacterium butyri fluorescens Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 120.

Pseudomonas centrijugans (Wright), Chester. (Bacillus centrijugans Wright, Mem. Nat. Acad. Sci., 7, 1895, 462, Bacterium centrijugans Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 95; Chester, Man. Determ Bact., 1901, 312.) From water.

Pseudomonas coadunata Chester syn Bacterium coadunatus Chester, Ann. Rept. Del Col. Agr. Exp Sta, 9, 1897, 90.

Pseudomonas coenobios ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 272.) From film of marine fouling organisms.

Pseudomonas cohaerea (Wright) Chester, not Bacillus cohaerens Gotheil, Cent f. Balt., II Abt, 7, 1901, 455; Bacterium cohaereus (sic) Chester, Ann. Rept Del. Col. Agr. Exp Sta., 9, 1897, 93.

Pseudomonas coli communis Conn, Esten and Stocking. (Storra Agri, Evp. Sta, Conn, 18th Ann. Rept. for 1906, 186) From cheddar cheese Like Bacillus coli communis except that it has a single, long flagellum.

Pseudomonas conreza Chester syn. Bacterium fluorescens contexus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 123.

Pseudomonas corallina Humm (loc. cit., 59). From marine algae of all common species at Beaufort, Nor. Car. Digests agar.

Pseudomonas delabens (Wright) Chester syn. Bacterium delabens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9,

1897, 97.

Pseudomonas eisenbergii Migula syn. Bacterium fluorescens non-liquefaciens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 124.

Pseudomonas elongata Humm (loc. cit., 60). From intertidal sand, Atlantic Beach, Nor. Car. Digests agar.

Pseudomonas enalia ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 254.) From sea water and marine mud.

Pseudomonas fairmountensis (Wright) Chester syn. Bacterium fairmountensis Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 90.

Pseudomonas felthami ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif, 5, 1944, 267.)
From marine mud

Pscudomonas fimbriata (Wright) Chester syn. Bacterium fimbriatus Chester, Ann Rept Del. Col. Agr. Exp. Sta., 9, 1897, 95

Pseudomonas floridana Humm (loc. cit., 60) From algae and beach sand at Miami, Fla, and Beaufort, Nor. Car Directs agar.

Pseudomonas fluorescens Migula syn. Bacterium fluorescens liquefacions Chester, Ann. Rept. Del. Col Agr Exp Sta., 9, 1897, 120

Pseudomonas foliacea Chester syn. Bacterium fluorescens foliaceus Chester, Ann. Rept. Del. Col Agr Exp Sta., 9, 1907 193

1897, 122.

Pseudomonas geniculatus (Wright) Chester. Bacillus geniculatus Wright, not Bacillus geniculatus DeBary, Inaug Diss., Strassburg, Leipzig, 1885; not Bacillus geniculatus Trevisan, I generi e le specie delle Batteriacee, 1889, 16; syn, Bacterium geniculatus Chester, Ann, Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 95

Pseudomonas humicola Bersteyn, (Arb. bakt. Inst. Karlsruhe, 5, 1903, 97.) From soil.

Pseudomonas hypothermis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 276) From marine bottom denosits.

Pseudomonas incognita Chester syn. Bacterium fluorescens incognitus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 122.

Pseudomonas indoloxidans Gray. (Proc. Roy. Soc. London, B, 102, 1928, 263.) From soil from Italian Tyrol.

Pseudomonas indigoferus (Voges) Mi-(Bacillus indigoferus Voges, Cent. f. Bakt., 14, 1893, 307; Bacterium indigoferus Chester, Ann. Rept. Del. Col. Agr. Evp. Sta., 9, 1897, 118; Migula, Syst. d. Bakt., 2, 1900, 950) From Kiel tap water (Voges); from Delft ditch water, mud and garden soil (Elazari-Volcani, Arch. f. Mikrobiol., 10, 1939, 357). Some authors regard Voges' organism as identical with Claessen's indigo blue bacillus, see Pseudomonas berolinensis. Pseudomonas indigoferus var. immobilis Elazari-Volcani. (Arch. f. Mikrobiol , 10, 1939, 350.) From ditch mud. See Lehmann and Neumann (Bakt Diag , 1 Aufl., 2, 1896, 267) who also had a non-motile strain (Bacterium indignnaceum) from Kral which they considered identical with Claessen's indige blue bacillus.

Pseudomonas mertia Humm (loc. cit., 61) From intertidal sand, Atlantic Beach, Nor. Car. Digests agar.

Pseudomonas sris Migula syn. Bacellus fluorescens crassus Kruse, in Flugre, Die Mikroorganismen, 3 Aufi, 2, 1896, 211, Bacterium fluorescens crassus Chester, Ann Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 134; Bacterium iris Chester, idem, 137.) From sputtum.

Pseudomonas jaegeri Migula syn. Bac-

terium proteus fluorescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sts, 9, 1897, 119, and Bacillus urinas Chester, Man Determ. Bact., 1901, 263

Pseudomonas javanica (Eijkmann) Migula syn. Bacterium javanicasis Chester, Ann. Rept. Del. Col. Agr. Exp Sta,

9, 1897, 111.

Pesudomonas liquida Chester. (Bacillus liquidus Frankland and Frankland, Ztschr f. Hyg., 6, 1889, 382; Chester, Man. Determ. Bact., 1901, 311, Achromobacter liquidum Bergey et al., Manual, lated., 1923, 145) From water. Originally described merely as motile, Chester recognizes the species as polar flagellate and lists Bacillus liquifaceus communis Sternberg and Bacillus aquatitis communis Kruse as synonyms

Pseudomonas longa Migula syn. Bacterium fluorescens longus Chester, Ann. Rept. Del Col. Agr. Exp. Sta, 9, 1897, 124.

Pseudomonas macroselmis Migula syn.

Bacillus fluorescens putidus Chester,

Ann. Rept Del Col. Agr. Exp Sta., 9,

1897. 121.

Pseudomonas marinopersica ZoBell and Uplam. (Bull. Scripps Inst. of Occanography, Univ. Cahf., δ, 1944, 275.) From marine bottom denosits

Pseudomonas melochlora (Winkler and Schrotter) Migula syn. Bacterium melochlorus Chester, Ann. Rept. Del Col Agr. Exp Sta., 9, 1897, 120, see abst in Cent. f Bakt., 9, 1891, 700

Pseudomonas membranula ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ Calif., δ, 1944, 270) Sessile form found on slide submerged in sea.

Pseudomonas minutissima Migula syn Bacterium fluorescens minutissimus Chester, Ann Rept. Del. Col Agr. Evp Sta., 9, 1897, 120

Pseudomonas monadiformis (Kruse) Chester syn. Bacterium monadiformis Chester, Ann Rept Del Col. Agr. Exp. Sta., 9, 1897, 69; Racterium coli mobilis Chester, ibid, 69 Pseudomonas multistriata (Wright) Chester syn. Bacterium multistriatus Chester, Ann. Rept. Del. Col Agr Exp. Sta., 9, 1897, 90.

Pseudomonas nebulosa (Wright) Chester syn. Bacterium nebulosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807 03

Pseudomonas nertica ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ Calif, 5, 1914, 255.) From sea water and making mud.

Pseudomonas nexibilis (Wright) Chester syn. Bacterium nexibilis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1807. 74

Pseudomonas obscura ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 274) From marine bottom denosits

Pseudomonas oceanica ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 266.) From marine mud.

Pseudomonas ochracea (Zimmermann) Chester syn. Bactersum ochraceus Chester, Ann Rept. Del Col. Agr Exp Sta., 9, 1897. 104.

Pseudomonas oralis Chestersyn. Bacterium fluorescens ovalis Chester, Ann. Rept. Del Col. Agr Exp Sta., 9, 1897, 123

Pseudomonas pallescens Migula syn Bacterium viridis pallescens Chester, Ann. Rept Del Col. Agr. Exp. Sta., 9, 1897, 124

Pseudomonas perfectomarinus ZoBell and Upham. (Bull. Scripps Inst. of Occanography, Univ. Calif., 5, 1944, 277.) From sea water and marine mud

Pseudomonas periphyta ZoBell and Uphan (Bull Scripps Inst. of Oceanography, Univ Calit., 5, 1914, 276) Sessile form found in film of marine fouling organisms.

Pseudomonas phosphorescens (Fisher)
Bergey et al. syn Pasteurella phosphorescens Trevssan, I generie e le specie
delle Batternacce, 1889, 21; Bacillus phosphorescens indicus Insenberg, Bakt.

Diag., 3 Aufl., 1891, 123; Vibrio indicus Lehmann and Neumann, Bakt. Diag., · 1 Aufl., 2, 1896, 341; Bacterium phosphorescens indicus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 120; Photobacter indicum Beijerinck, Proc. Sect. Sci., Kon. Akad. v. Wetensch., Amsterdam, 3, 1900, 352; Microspira phosphorescens Chester, Man. Determ. Bact., 1901, 333; Bacillus indicus Beijerinck, Folia Mikrobiologica, Delft, I, 1912, 1. Beijerinck (loc. cit., 1900) discusses two variants of this species: Photobacter indicum var. obscurum and Photobacter indicum var. narrum. Later, Beijerinck (loc. cit , 1912), in discussing mutants of this species, proposes the species names Bacillus indicus varrus, Bacillus indicus semiobscurus and Bacillus indicus obscurus.

Pseudomonas piscora Hanzawa and Takeda. (Jozogaku Zasshi, Osaka, Japan (Jour. of Zymology), 9, 1931, 571; quoted from Takeda, Cent. f Bakt., II Abt., 94, 1936, 46) From discased sal-

mon eggs.

Pseudomonas plcomorpha ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 275.) From marine bottom deposits.

Pseudomonas pullulans (Wright) Chester syn. Bacterium pullulans Chester, Ann. Rept. Del. Col. Agr. Exp.

Sta , 9, 1897, 105.

Pseudomonas puris Patrick and Werkman. (Proc. Iowa Acad. Sci., \$7, 1930, 57.) From a typhoid-like infection of snakes.

Pseudomonas ribicola Bohn. (Jour. Agr Res , 73, 1946, 288) From the na-

tive current, Ribes aureum

Pseudomonas riboflavinus Foster. (Jour. Bact., 47, 1944, 30.) Oxidizes riboflavin to lumichrome. From riboflavin-rich soil

Pseudomonas roscola Humm (loc. cit, 62) From intertidal sand, Atlantic Beach, Nor Car. Digests agar

Pseudomonas rugosa (Wright) Chester syn. Bacterium rugosus Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 122.

Pseudomonas schuylkilliensis Chester syn. Bacterium fluorescens schuylkilliensis Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 119

Pseudomonas scissa (Frankland and Frankland) Migula syn. Bacterium scissus Chester, Ann. Rept. Del Col. Agr.

Evp Sta., 9, 1897, 143.

Pseudomonas sessilis ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 239.) Sessile form found on solid surfaces submerged in the sea.

Pseudomonas sinuosa (Wright) Chester syn. Bacterium sinuosus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 69

Pseudomonas smaragdina Migula syn. Bacterium smaragdino foetidus Chester, Ann. Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 119; and Bacillus smaragdinus Chester, Man, Determ. Bact., 1901, 263

Pseudomonas sterotropis ZoBell and Upham. (Bull. Scripps Inst. of Oceanorgraphy, Univ. Calıf., 5, 1944, 272) From a film of marine fouling organisms Pseudomonas striata Chester syn Bacterium striatus viridis Chester, Ann Rept. Del. Col. Agr. Evp. Sta 9, 1897,

Pseudomonas syncyanea Migula syn. Bacterium syncyanus (sic) Schroeter, Beitr. z. Biol. d. Phanz., f, Heft 2, 1872, 126 and Bacterium cyanogenum Zopf, Die Spaltpilze, 2 Aufl., 1884, 50; may be in 1 Aufl.

Pseudomonas synzantha (Ehrenberg) Holland. (Vibrio synzanthus Ihrenberg, Verhandl. d. Berl. Akad., 1840, 202, Vibrio zanthogenes Fuchs, Magazin f. d. ges. Tierheilk., I., 1841, 193; Bacterum Charles of Color Beiträge.

> 120; 1kro-

terium synxanthum Bergey et ai, Manual, 1st ed., 1923, 102; Holland, Jour Bact, 5, 1920, 220) Bergey et al. (Manual, 1st ed., 1923, 102) give Batterium zanthogenes as a synonym From milk and cream. Polar flagellate (Hammer, personal communication). See Hammer, Res. Bul 20, 16wa Agr. Evp. Sta., 1915, for a description of this organism

Pseudomonas tenuis Migula syn. Bacterium fluorescens tenuis Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 124.

Pseudomonas turcosa Migula syn. Turkisfarbener Bacillus, Tataroff, Inaug. Diss.. Dorpat. 1891. 52.

Pseudomonas tadosa ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ Calif, 5, 1944, 263) From sea water and marine bottom denosits

Pseudomonas vendrelli Tobie. (Pseudomonas vendrelli (sic), mentioned by Farrell and Wolff, Jour. Ind and Eng. Chem., 55, 1911, 1186, U. S. Patent 2,227,718, Mar., 1912, issued to Lockwood et al., Bacillus vendrelli Lasseur, Dupaix-Lasseur and Melcion, Travaux Lab Microbiol. Fac. Pharm Nancy, Fase 13, 1914;—393. Isolated by W. C. Tobie in 1933 from well near Ponce, Puerto Rico owned by Mr Vendrell (Tobie, Jour. Bact, £8, 1916, 685). Presumably Pseudomona acrugnosa companyama con the second second

Pseudomonas virescens (Frick) Migula syn Bacterium virescens Chester, Ann. Rept. Del. Col. Agr. Exp. Sta, 9, 1897, 124.

Pseudomonas tiecosa (Frankland and Frankland) Migula syn. Bacterium viscosus Chester, Ann. Rept Del. Col. Agr. Exp. Sta. 9, 1897, 145, not Bacterium viscosum Weldin and Levine, Abst Bact., 7, 1923, 16

Pseudomonas ranthochrus ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calit., 5, 1944, 279) From marine bottom deposits.

Rambacterium alactolyticum Prévot and Taffanel. (Ann Inst. Past, 63, 1912, 259) From an osteophicgmon of the mixillary bine. Salmonella atherton Ferris, Hertzberg and Atkinson (Med. Jour. Australia, 32, 1945, 368.) From 29 cases of gastroenteritis in an army bosontal

Salmonella tuphosa (Zopf) White syn Bacillus typhicus Cabral and Da Rocha, I Trabalhos do Cabinette de Microbiologia; abst in Ann de Micrographie, 2 1889-1890, 295

, 1889-1890,

Sarcina pelagia ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ Calif, 5, 1944, 279) From sea water and marine bottom deposits

Serratia fuchsina Bergey et al. syn. Proteus fuchsinus Pribram, Klassifikation der Schizomyceten, Leipzig und Wien. 1933, 73

Serratia indica (Eisenberg) Bergey et al syn Bactillus indicus ruber Flugge, Die Mikroorganismen, 2 Aufi, 1886, 285; Bacterium indicum Crookshank, Manual, 1887, 240

Spirallum parrum Esmarch (Cent. f. Bakt, I Abt., Orig, 52, 1902, 565; also see Zettnow, thid, 78, 1916, 1)

From decaying organic matter

Spirillum sputgenum Flugge (Levis, Lancet, Sept 20, 1884; Flugge, Die Mikroorganismen, 2 Aufl, 1886, 387, Pacinia levisi Treysan, I generi e le specie delle Batteriacce, 1889, 21) From sputum.

Staphylococcus activus Prévot and Taffanel. (Ann. Inst Past, 71, 1915, 102.) From puerperal septicemia. Anaerobic.

Staphylococcus citreus duodenalis Gessner. (Arch f. Hyg, 9, 1889, 136) From the human duodenum.

Staphylococcus magnus Black. (Trans Ill. State Dental Soc, 22, 1886, 188) From the mouth.

Staphylococcus medius Black (Trans, III. State Dental Soc, 22, 1886, 190) From the mouth,

Staphylococcus pyogenes bovis Lucet (Ann Inst. Past., 7, 1893, 327.) From bovine abscesses

Staphylococcus uscusus Goadby.

(Mycology of the mouth, London, 1903, 172.) From the mouth.

Streptobacterium dextranicum Perquin. (Jour. Microbiol. and Serol., 6, 1940, 226.) Produces slime from sucrose solutions.

Streptococcus aquatilis Vaughan. (Amer. Jour. Med. Sci., 104, 1892, 184.) From water.

Streptococcus liquefaciens Frankland and Frankland. (Phil. Trans. Roy. Soc. London, 178, B, 1888, 261.) From air. After the section covering Streptococcus liquefaciens Sternberg emend, Orla-Jensen was in page proof, it was discovered that Frankland and Frankland had discovered and named a liquefying streptococcus earlier than Sternberg. The Franklands described this species as producing a yellow pigment.

Streptococcus pyogenes duodcnalis Gessner. (Arch. f. Hyg., 9, 1889, 132.) From the human duodenum.

Streptococcus tactic (Olsen-Sopp) Buchanan and Hammer. (Bacterium lactis longi Troil-Petersson, Zischr. f. Hyg., \$2, 1899, 361 and Milchreitung, 28, 1899, 438; Streptobacillus tactic Olsen-Sopp, Cent. f. Bakt., II Abt., \$3, 1912, 9; Buchanan and Hammer, Iowa Sta. Coll. Agr. Exp. Sta., Res Bull. 22, 1915, 277.) Probably the characteristic organism of Swedish ropy milk. Olsen-Sopp (locit.) misquotes Troili-Petersson's name as Bacillus acidi lactis longus (see Troili-Petersson, Cent. f. Bakt., II Abt., \$3, 1913, 1)

Thiospra agitissima (Gickihorn) Bavendamm. (Spirillumagitissimum Gickihora, Cont. f. Bakt., 11 Abt., 50, 1920, 418; Bavendamm, Die farblösen und roten Schweflbakterien, Pflanzenforschung, Heft 2, 1924, 116) From the pond in the Annen Castle Park, Graz, Austria. Contains grams of sulfur.

Thiospira elongata Perfiljev (Ber. d Sapropel Komm. Petrograd, 1923, 56) From mud containing H<sub>2</sub>S

Thiospira propera Hama. (Jour. Sci

Hiroshima Univ., Ser. B, Bot., 1, 1933, 157; abst. in Cent. f. Bakt., II Abt., 91, 1934, 200.)

Thiospira sulfurica Issatchenko (Biological observations on the sulfur bacteria (Russian), about 1927, 16 pp.)

Vibrio adaptatus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 258.) From sea water and marine scdiments.

Vibrio agarlyticus Cataldi. (Rev. d Inst. Bact. (D.N.H.), Buenos Aires, 9, 1940, 375.) From activated sludge Digests agar.

Tibrio albensis Lehmann and Neumann syn. Vibrio dunbari Holland, Jour. Bact., 6, 1920, 226; probably Vibrio phosphorescens Jermoljewa, Cent. f. Baht, I Abt, Orig., 100, 1928, 170; not Vibrio phosphorescens Holland, lee. cit.

Vibrio algosus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 257.) Associated with marine kelp.

With marine kelp.

Vibrio amphibolus Trevisan. (Babes,

Zitschr. f. Hyg., 5, 1888, 183; Trevisan,

I generi e le specie delle Batteriacce,

1889, 23.) Anaerobe.

Vibrio avidus Humm (Duke Univ Marine Lab., North Carolina, Bull. 3, 1946, 54.) From intertidal sand, Beaufort, North Carolina. Digests agar

Vibrio choleroides α and β Bujwid syn. Bacterium, choleroides Chester, Ann. Rept. Del. Col Agr. Exp. Stn., 9, 1897, 131.

Vibrio costicolus Smith and Vibrio costicolus var. liquefaciens Smith. (Roy. Soc Queensland, Proc. for 1937, 49, 1939, 20 and 32.) From tainted ribs of bacon and tank brines in bacon factories Active growth in 4 to 15 per cent brines

Vibrio euprima, Vibrio yasakii, Coccobacillus tolega and Coccobacillus sepiola Majima, Sci i Kwai- Med. Jour. 50, 1931, 41-67; sce Warren, Jour. Bact., 49, 1945, 543) Phosphorescent bacteria.

Vibrio fortis Humm (loc. cit., 55). From seaweed (Gracilaria conferioides). Digests agar. Vibrio frequens Humm (loc. cit., 56) From marine algae (Cladophoropsis, Laurencia poitei, etc.) Digests agar.

Vibrio halonitrificans Smith. (Roy. Soc. Queensland, Proc for 1937, 49, 1938, 29.) From tank brines in bacon factories. Active growth in 4 to 10 per cent brines

Vibrio haloplanktis ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 261) Sessile form found associated with marine phytoplankton

Vibrio hyphalus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., δ, 1944, 277.) From marine bottom deposits.

Vibrio marinagilis ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif, 5, 1944, 264.) From sea water and marine mud.

Vibrio marinoflavus ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1944, 258) From sea water.

Vibrio marinofulvus ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calif, δ, 1914, 262) From sea water.

Vibrio marinopraesens ZoBell and Upham (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1944, 256) From sea water.

Vibrio marinorulgaris ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Cahf, δ, 1944, 261) From sea water

Vibrio notus Humm (loc cit, 56). From intertidal sand, Atlantic Beach, North Carolina. Digests agar

Vibrio perimastrix Alarie. (Alarie, Thesis, MacDonald Coll MeGill Univ, 1945, see Perlin and Michaelis, Sci., 103, 1946, 673) Will decompose cellulose only in presence of CO:

Vibrio phytoplankiis ZoBell and Upham. (Bull. Scripps Inst of Oceanography, Univ. Calif., 5, 1944, 261.) From sea water and marine phytoplankton.

Vibrio pieris Paillot. (Compt. rend. Soc. Biol., Paris, 94, 1926, 68.) From caterpillars of the cabbage butterfly (Pieris brassicae) which had been parasitized by larvae of apartlets elomeratus.

Vibrio ponticus ZoBell and Upham. (Bull Scripps Inst. of Oceanography, Univ. Cahi, 5, 1944, 259) From sea water

Vibrio rumpel Lode (Cent. f. Bakt., I Abt., Orig., 35, 1903, 526; see Ballner, Cent. f. Bakt., II Abt., 19, 1907, 572.)

Cent. I Bakt., II Abt., 19, 1907, 5/2.)
From Water. Phosphorescent.
Vibrio stanieri Humm (loc. cit., 57).
From seaweed (Acanthophora smicilera).

Miami, Fla. Digests agar.

Vibrio turbidus Humm (loc. cit., 57).

From seen and (Grandana conformade).

From seaweed (Gracularia confervoides)
Digests agar.

Vibrio viridans Miller. (Quoted from Miller, Microorganisms of Human Mouth, Phila., 1890, 85, see Miller, Die Mikroorganismen der Mundhöhle, Leipzig, 1889.) From the mouth

Xanthomonas translucens var. phleipratensis Wallin and Reddy. (Phytopathology, 35, 1945, 939) The cause of a bacterial streak disease on timothy grass (Phleum pratense)

Xanthemenas vignicola Burkholder (Phytopath, \$4, 1944, 431.) From cowpea, Vigna sinensis.

Yersinia van Loghem (Ann. Past. Inst., 72, 1916, 975), a genus proposed to include Pasteurella pestis and P. pseudotuberculosis

Ein neuer fur Thiere path, Mikroorg, aus dem Sputum eines Pneumoniekanken, Bunzel and Federn, Arch. f. Hyg. 19, 1803, 326, Bacillus dubus pneumoniae 
Kruse, in Flüger, Die Mikroorganismen, 
3 Aufl. 2, 1806, 419; Bacterium zubpneumonieum Migula, Syst d. Bakt. 2, 1900, 376; Bacterium dubum Chester, 
Man. Determ. Bact., 1901, 142. From 
the sputum of a pneumonia patient.

# FAMILY XIII. BACILLACEAE FISCHER.

(Jahrb. f. wiss. Bot., 27, 1895, 139.) Rod-shaped cells, capable of producing spores, either with peritrichous flagella of

non-motile, monotrichous flagellation has been reported but is doubtful. Endospores are cylindrical, ellipsoidal or spherical, and are located in the center of the cell, sub-terminally or terminally. Sporangia do not differ from the vegetative cells except when bulged by spores larger than the cell diameter. Such sporangia are spindleshaped when spores are central, or wedge- or drumstick-shaped when spores are terminal. Usually Gram-positive. Pigment formation is rare. Aerobic, microaerophilic or anaerobic. Gelatin is frequently liquefied. Sugars are generally fermented, sometimes with the formation of visible gas. Some species are thermophilic, i e., will grow readily at 55°C. Mostly sapronhytes, commonly found in soil. A few are animal, especially insect, parasites or pathorens.

## Key to the genera of family Bacillaceae.

- I. Aerobic; catalase positive.
- Genus I. Bacillus, p. 705. II. Anaerobic or microaerophilic; catalase not known to be produced. Genus II. Clostridium, p. 763

### INTRODUCTION TO THE GENUS BACKLUS.

In the fifth edition of the Manual, the late F. D. Chester stated; "It is difficult to offer a rational system of classification for the described forms of the genus Bacillus because of the incompleteness of the data". He prepared a splendid review of the literature but naturally could not supply the data that were missing. He stated further that "The majority of the so-called species in the genus have been imperfectly presented, . . . the net result being that there are comparatively few clearly and definitely described species among the many herein recorded. The development of a better knowledge will be a work of the future". He then discussed the type of nork that should be done. A reading of his statement is recommended to anyone contemplating naming a new species.

During the past few years, the writer with the assistance of Francis E Clark and Ruth E. Gordon has made a study of the genus Bacillus along the lines indicated by Chester. Representative cultures have been obtained from various laboratories, institutions, and private collections Special mention should be made of the private collection of Prof. J. R. Porter, now at the Iowa State University. It contained about 200 named species and was invaluable for the work. As a result of this study, it appears that many species have been differentiated by such simple characters as mucoid, folded, adherent or rhizoid growth, pigment production, the fermentation of a specific Carbabydeate etc Others have been grouped because of some special physiological -- 11 loge ate Ches-

, ment on Species have been characterized upon a blood boom the assumption that one species should not dissociate into another species. Since certain characters are more stable than others, these have been used to establish a

<sup>\*</sup> Revised by Mr. Nathan R. Smith, U. S. Bureau of Plant Industry Station, Beltsville, Maryland (Bacillus), August, 1943, and Prof. R. S. Spray, School of Medicine, West Virginia University, Morgantown, West Virginia (Clostridium), May, 1942.

species pattern. This has reduced the number of species of the mesophilic members of the genus from many poorly defined organisms to a few well characterized and delimited species. Intermediates occur between related species and have been treated as such. The report on which this arrangement is based has recently been published by Smith, Gordon and Clark (U. S. Dept. Agr. Misc. Pub. No. 559, 1916, 112 pn.).

Some workers may think that the cut in the number of species has been too drastic and that certain organisms listed as varieties, morphotypes, or botypes should be retained as species. This would not be consistent with the newer knowledge of bacteriology that has been developed during the past two decades. No doubt other species occur in nature that are not included herein. But before jumping to the conclusion that a culture is a new species, closely related organisms as well as the isolate should be studied along the lines given by Chester in the fifth edition of the Manual.

The production of indole and the formation of H<sub>2</sub>S have been omitted from the descriptions because these characters have no taxonomic value. Certain other properties, such as colony form, character of the growth on slants, in litmus milk, etc., have a very limited value. They are included for the sake of completeness

#### Genus I. Bacillus Cohn \*

(Beitrage 2 Biol. d. Pflanzen, 1, Heft 2, 1872, 146 and 175) From Latin bactilium, a small stick.

Synonyms, ? Bactrella Morren, Bull. d. Sci. natur et. de Geol., No. 27, 1830, 203; ? Metallacter Perty, Zur Kenntniss kleinster Lebensformen, 1852, 180; ? Bacteridium Davaine, Diet, Encyclon, d. Sci. Med., Ser. I. 8, 1868, 21; Pollendera Trevisan, 1884 (see DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 943); Zopfiella Trevisan, Attı della Accademia Fisio-Medico-Statistica in Milano, Ser. 4, 5, 1885, 93; Cornila Trevisan I generi e le specie delle Batteriacce, 1889, 21: Urobacillus Miquel. Ann Microg . 1, 1889, 517, Bacterium Migula, Arb, bakt Inst Karlsruhe, 1, 1894, 237 (not Bacterium Ehrenberg, Symbolae Physicse seu Icones et Descriptiones Animalium, etc., Berlin, 1828, 8); Bactrinum, Bactridium, Bactrillium. Clostrillium. Clastrinium and Paraclaster Fischer, Jahresb, f wissensch, Bot , 27, 1895, 139; Endobacterium Lehmann and Neumann, Bakt. Diag , I Aufl , 2, 1896, 103 , Astasia Meyer, Flora, 84, 1897, 185; Saccharobacter Benjerinck, Cent f Bakt, II Abt, 6, 1900, 200; Fenobacter Beijerinck, ibid ; Aplanobacter E F Smith, Bact. in Relation to Plant Dis . 1. 1905, 171. Semiclostridium Maassen, Arb. a d k Gesundheitsamte. Biol. Abt . 5, 1905. 5; Muzobacillus Gonnermann, Ztschr. f. Zuckerind, u. Landwirtsch., 36, 1007, 877; Plennobacterium Gonnermann, abid ; Serratia Vuillemin, Ann. Mycolog., 11. 1913, 521 (not Serratia Bizio, Polenta porporina, Biblio Ital., 30, 1823, 288); Schaudinnum, Theciobactrum, Zygostasis, Eisenbergia, Migulanumand Rhagadascia Underlein, Sitzber, Gesell, Naturf Freunde, Berlin, 1917,309; Cellulobacillus Simola, Ann Ac. Sc Fenn , Ser. A, \$4, No 1 and 6, 1931 (abst in Cent f. Bakt . II Abt., 89. 1932, 89), not Cellulobacullus Orla-Jensen, Cent. f. Bakt., II Abt , 22, 1909, 343; Zumobacellus Kluyver and Van Niel, Cent f. Bakt., II Abt , 94, 1936, 369.

Rod-shaped bacteria, sometimes in chains Sporangia usually not different from the vegetative cells Catalase present. Aerobic, sometimes showing rough colonies and

Revised by Mr. Nathan R. Smith, U. S. Bur. Plant Industry Station, Beltsville, Maryland, August, 1943.

- b. Growth below 50°C.
  - c. Nitrites from nitrates, often with liberation of nitrogen gas.

· 21. Bacillus kaustophilus. 21a. Bacillus pepo.

- cc. No nitrites from nitrates.
- 22. Bacillus thermoindifferens. bb. No growth below 50°C. 23. Bacillus thermodiastaticus.
- 2. Diameter of rods greater than 0.8 micron.
- a. Growth on nutrient agar.
  - b. Remnants of sporangium adherent.
  - 21. Bacillus cylindricus.
  - bb. Remnants of sporangium not adherent. 25. Bacillus robustus.
    - 25a. Bacillus losanitchii.
  - aa. No growth on nutrient agar.
- 26. Bacillus calidolactis.
- B Spores ellipsoidal to cylindrical, central to terminal; sporangia distinctly bulged.
  - 1. Diameter of rods less than 0.9 micron.
    - Starch hydrolyzed.
      - b. Nitrites from nitrates, sometimes with liberation of nitrogen gas.
        - 27. Bacillus michaelisii.
        - 27a. Racillus lobatus.
      - 27b. Bacillus thermononliquefaciens. bb. No nitrites from nitrates.
        - Action on cellulose not recorded.
        - 28. Bacillus thermotranslucens.
          - 28a. Bacillus stearothermophilus.
          - 28b. Bacillus aerothermophilus.
        - ce. Cellulose hydrolyzed.
        - 29. Bacillus thermocellulolyticus.
    - na Starch not hydrolyzed.
      - b. Nitrites from nitrates, sometimes with gaseous nitrogen. e. Milk unchanged.
        - 30. Bacillus thermoalimentophilus.
        - ce Milk acid, coagulated.
  - 31. Bacillus thermoliquefaciens. 2 Diameter of rods greater than 0 9 micron.
    - a Starch hydrolyzed
      - h No nitrites from nitrates
        - 32. Bacillus tostus.
- C Spores spherical, central to terminal; sporangium not distinctly bulged, 33. Bacillus viridulus.
- 1. Bacillus subtilis Cohn emend Prazmowski (Cohn, Beitr. z Biol. d. Pflanzen, f, Heft 2, 1872, 174; Heft 3, 1875, 188; 2, Heft 2, 1876, 249; Prazmowski, Untersuchungen uber die Entwicklungsge-

schichte und Fermentwirkung einigen Bakterien-Arten. Inaug. Diss., Leipzig, 1880 ) From Latin subfilts, slender.

The identity of this species has been

the subject of some controversy owing to the indefiniteness of the original descriptions, to the distribution of cultures under the name Bacillus subtilis that were incorrectly identified, to variations in the forms of growth that may be observed, and to confusion with Bacillus cereus In cases where Bacillus subtilis is said to be "anthrax-like," or "similar to the anthrax bacillus," it should be remembered that these terms apply to Bacillus cereus and not to Bacillus subtilis Conn (Jour. Inf. Dis. 46, 1930, 341) concluded that the so-called Marburg strain fitted the earliest recognizable description of this species which is that given by Prazmowski (loc. cit.), and his view was accepted after a study of cultures by the International Committee on Bacteriological Nomenclature (Jour. Bact . 33, 1937, 445)

During the past two decades much procress has been made in the study of variations in the stages of growth of bacteria, the rough, smooth, mucoid, etc., and in the variability in physiology as From the recent work of Smith, Gordon, and Clark (loc cit ) it appears that many species have been characterized on such simple grounds as growth folded, mucoid, adherent, colored, thizoid, etc., all of which are subject to variation, either induced or spontaneous The present arrangement of this species is the result of their work combined with data supplied by the work of Conn and others

Species probably identical with or variants of Bacillus subtilis:

Bacillus geniculatus de Bary, Beitrag zur Kenntnis der niederen Organismen ım Mageninhalt, Inaug. Diss , Strassburg, Leipzig, 1885, Bacillus mesentericus fuscus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 321 (Bacillus mesentericus Trevisan, I generi e le specie delle Batteriacee, 1889, 19, not Bucillus mesentericus as interpreted by Chester, Del. Agr. Exp Station 15th Ann. Report, 1903, 86; not Bacillus mesentericus as given by Lawrence and Ford, Jour Bact . 1, 1916. 295);\* Bacillus mesentericus vulgatus Flugge, Die Mikroorganismen, 2 Aufl., 1886, 322 (Bacillus vulgatus Trevisan, I genera e le specie delle Batteriacee, 1889, 19), Bacillus liodermos Flucce, Die Mikroorganismen, 2 Aufl , 1886, 323 (Bacillus No. X. Flurge, Ztschr. f Hyg., 17. 1894, 296; Bacillus lactis No. X. Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 209; Bacillus intermedius Migula, Syst d. Bakt., 2, 1900, 579; Bacillus eremoris Chester, Man Determ Bact., 1901, 274), Bacillus laeus Frankland and Frankland, Philos Trans Roy. Soc. London, 178, B, 1887, 278 (not Bacillus laevis Distaso, Cent f. Bakt., I Abt., Orig , 62, 1912, 444); Tyrothrix tenuis Duclaux, Ann Inst Nat. Agron . 4. 1882. 23 (Bacillus tenuis Trevisan, I generi e le specie delle Batteriacee, 1889, 16); Kartoffelbacıllus, Globig, Ztschr. f Hyg., 3, 1888, 294 (Bacillus roscus Trevisan, loc. cit . 19, Bacillus mesen-

tericus ruber Kruse, in Flugge, Die

<sup>\*</sup>T. Gilson, University of Edinburgh (personal communication), has found that the European and supposedly the original strains of Bacillus meentericus hydrolyze starch and reduce nitrates to nitrites, whereas the American strains are negative in both of these characters. Furthermore, the latter are usually smooth and when the rough stage evists, it does not resemble a mesentery from which the organism derived its name. This term, however, can still be applied to the Luropean strains. Since the American strains are identical with Bacillus pumilus (Chester, Del. Agr. Evp. Station, 18th Ann Report, 1903, 87; Lawrence and Ford, Jour Bact. 1, 1916, 300), it has been recommended (Smith, Gordon, and Clark, loc cit) that they be designated as Bacillus pumilus to avoid ambiguity. Since the European Bacillus meentericus is only a stage of growth of Bacillus withits, the former name should be dropped.

Mikroorganismen, 2, 1896, 199; Bacillus globigii Migula, Syst. der Bakt., 2, 1900, 554: Bacillus vitalis Chester, Man. Determ. Bact., 1901, 286); Bacillus leptosporus Klein, Cent. f. Bakt., 6, 1889, 316; Bacillus No. 6, Pansini, Arch. f. nath. Anat. u. Physiol., 122, 1890, 422 (Bacıllus coccoideus Migula, Syst. der Bakt. 2, 1900, 558); Bacillus radians Migula, Syst. d. Bakt., 2, 1900, 580 (Bacillus No. IX, Flugge, Ztschr. f. Hyg , 17, 1894, 296; Bacillus lactis No. IX, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 209: Bacillus stellatus Chester, Man. Determ, Bact .. 1901, 274; not Bacillus stellatus Vincent, Ann. Inst. Past., 21, 1907, 69); Bacillus mesentericus panis viscosi II Vogel. Ztschr. f. Hyg., 26, 1897, 401 (Bacillus panis Migula, \*\* Syst der Bakt., 2, 1900. 576); Bacillus armoraciae Burchard, Arb. a. d. bakt. Inst. d. techn. Hochschule zu Karlsruhe, 2, 1898, 46; Bacillus idosus Burchard, sbid., 47; Bacellus subtilis a Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 635, Bacillus natto Sawamura, Bull Coll Agr., Tokyo, 7, 1906, 108; Bucillus mesentericus var. flavus Laubach, Jour. Bact., 1, 1916, 497 (Bacillus flavus Bergey et al , Manual, 1st ed., 1923, 286, not Bacillus flavus Fuhrmann, Cent f Bakt., II Abt., 19, 1907, 117); Bacillus truffauti Truffaut and Bezssonoff, Compt rend Acad Sci., Paris, 175, 1922, 544; Bacillus mesentericus hydrolyticus Hermann and Neuschul, Biochem. Ztschr , 281, 1935, 219.

The name Vibrio subtilis Ehrenberg (Infusionsthierchen als vollkommene Organismen, Leipzig, 1838) scems to have given rise to the species name.

Spores: 0.6 to 0.9 by 1.0 to 1.5 microns, ellipsoidal to cylindrical, central or paracentral. Germination prevailingly equatorial.

Sporangia: Ovoid to cylindrical, only slightly bulged if at all.

Rods: 0.7 to 0.8 by 2.0 to 3 0 microns, single or in short chains, rounded ends, stain uniformly. Motile. Gram-positive. The following variations have been observed: Smaller or larger rods, filaments, encapsulated cells (the slim) bread organisms), few shadow forms, normotile and Gram-variable. Rods on glucose nutrient agar store small amount of fat.

Gelatin stab: Liquefaction.

Agar colonies: Usually rough, finely wrinkled, opaque, dull, adherent, slightly spreading, brownish tinge. Variations may be smooth, soft, thin, translucent, non-adherent, dendroid, coarsely wrinkled, creamy-white to yellowish to orange.

Agar slants. Growth abundant, flat, spreading, usually has a dull mat surface, finely wrinkled, adherent, becoming slightly brownish. Variations may be coarsely wrinkled or folded, non-adherent, smooth, thin, translucent, dendord, creamy-white to yellow to orange. Some strains show a greenish fluorescence when grown at 48°C on nutrient agar.

Broth Turbid becoming clear with formation of a tough, wrinkled pellicle. Milk. Slowly peptonized, becoming alkaline.

r.

<sup>\*\*</sup>There has been confusion about the identity of the so-called slimy bread bacteria. Lehmann and Neumann (Bakt. Ding, 7 Aufl, 2, 1927, 616) stated that they terially and also more or less closely related to Bacillus message for Bacillus.

From this and the work of Smith, Coulon and the slimy bread organisms are mucoid variants of Bacillus subtilis, which may or may not be encapsulated, and motile or non-matile (see also Bacillus subtilis var. viscosus Chester, Del. Agr. Exp. Station, 15th Ann. Report, 1903, 84).

Milk agar plate: Casein hydrolyzed Potato: Growth Juxuriant, warty or wrinkled to correctly folded whitish to nink or vellow becoming brownish with 820.

Nitrites formed from nitrates Starch is hydrolycod

Acid with ammoniacal nitrogen from xylose, arabinose, glucose, fructose, galactose, mannose, maltose, sucrose, salicin, glycerol and mannifol Henrily acted from dextrin. Variable reactions on rhamnose, raffinose, and inulin Usually no action on lactore

Acetylmethycarbinol produced

Citrates utilized

Optimum temperature 30° to 37°C Will usually grow from 50° to 56°C

Aerobic, facultative.

Source: Original cultures isolated by Cohn from an infusion of lentils (1872), from a boiled infusion of cheese and white beets (1875), and from boiled hay infusions (1876). Hence, frequently called the hay bacillus. The folded, non-adherent stage of growth ( Racillus vulgatus and the European strain of Bacillus mesentericus) is often called the potato bacillus Manner of germination of spores established by Prazmowski (loc cit.).

Habitat: Widely Listributed in soil and in decomposing of range matter

Nore: Bacillus tulgatus has long been separated from Bacillas subtilis by the folded character and the non adherence of its growth Recently Lamanna (Jour Bact , 44, 1942, 611) has attempted to separate this species from Bacillus subtilis by the splitting of the spore sheath along the transverse axis upon germination. Since the two species are otherwise morphologically and physiologically alike and since these characters are subject to valid . if he

es of growth; for instance, Bacillus sublilis

morphotype vulgatus (or mesenterieus) for the folded growth. Bacillus subtilus morphotype panis for the slimy growth. and Racillus subtilis mornhotype alabiaii for those that produce a red or orange nument. These terms would apply to the present condition of the culture and mould have to be abanged if the abarector of the growth changed

la Racillus subtilis var. alerrimus comb non (Potato bacullus Biel Cent f Bakt II Abt. g. 1896, 137: Bacillus aterramus Lehmann and Neumann, Bakt. Diag 1 Aufl. 2 1896, 303; Bacillus mesentericus niger Lunt, Cent, f. Bakt... II Abt. 2. 1896, 572, Bacellus niger Chester Man Determ. Bact , 1901, 306.1 From Latin aterranus very black ..

Syconyms . Bacillus nierificans Fabian and Nienhuis, Mich. Agric, Exp Station. Tech Bull 140, 1934, 24: Bacillus turosinggenes Rusconi, as referred to by Carbone et al , Instit. Sierot. Milan . 2. 1921-1922, 29: not Bacillus tyrosinogenes Hall and Finnerud, Proc. Soc. Expl. Biol and Med . 19, 1921, 48 and Hall. Abstr Bact , 6, 1922, 6.

In the early accounts the production of a blue-black to black pigment on notato was stressed It was also said to resemble Bacellus subtiles and Bacellus vulgatus on gelatin plates Recent work (Clark and Smith, Jour Bact , 57, 1939, 280) has shown that pigmentation occurs only in the presence of a carbohydrate. In addition (Gordon and Smith, Jour Bact.. 13. 1942, 55), it was established that the abiluv to form the pigment could be lost through serial transfers and colony selection and that the resultant dissociants could not be differentiated from Racillus subtilis

Source Isolated from rye bread in moist chamber used for growing some aspergilli (Biel).

Habitat. Widely distributed in soil.

1h Bacillus subtilis var niger comb. nov. (Bacillus lactis niger Gorini, Gior. d. Reale Soc. Ital. Ig , 16, 1894, 9; Bacillus niger Migula, Syst. der Bakt., 2, 1900, 636.) From Latin niger, black.

The black pigment characterizing this organism is formed only in media containing tyrosine (Clark and Smith, Jour. Bact., 37, 1939, 279). The ability to form the pigment may be lost through serial transfer and colony selection. It then cannot be separated from Bacillus subtilis (Gordon and Smith, loc, cit.)

Source, First isolated from milk. Habitat: Widely distributed in soil

2. Bacillus pumilus Gottheil. (Cent. f. Bakt., II Abt., 7, 1901, 681.) From Latin pumilus, dwarfish, little.

Synonyms: Bacillus mesentericus as interpreted by Chester, Del. Agrie. Exp. Station, 15th Ann. Report, 1903, 87; Bacillus mesentericus as given by Lawrence and Ford, Jour. Bact., 1, 1916, 295 and 300; Bacellus mesentericus var. flavus Laubach, Jour Bact., 1, 1916, 497; perhaps also Bacillus parvus Neide, Cent. I. Bakt., II Abt. 12, 1904, 344; Bacellus leptodermis Burchard, Arb a d bakt. Inst. d. techn Hochschule zu Karlsruhe, 2, 1808, 33

Spores: Ellipsoidal to cylindrical, thin walled, naked, central or paracentral, usually about 0 5 by 1 0 micron although some may approach the size of those of Bacillus subtilis

Sporangia · Ellipsoidal to cylindrical, not bulged.

Rods · 0 6 to 0 7 by 2 0 to 3.0 microns, usually occurring singly or in pairs. Chains, filaments and shadow forms may be found in some strains. Cells grown on glucose nutrient agar have few small fat globules Motile with peritrichous flagella Gram-positive.

Gelatin stab Slow liquefaction.

Agar colonies. Thin, flat, spreading, dendroid, smooth, translucent. The rough stage also occurs

Agar slants Growth moderate, smooth, soft, thin, glistening, non-adherent, spreading, usually whitish although it may be yellowish. The rough stage is tough and finely wrinkled, sometimes resembling certain strains of Bacillus subtilis.

Broth: Uniform turbidity, with or without a ring or half-formed pellicle. The rough stage forms a pellicle.

Milk: Peptonized, sometimes coagu-

Milk agar plate Casein hydrolyzed.
Potato: Growth is smooth, thin, spread-

ing, moist to slimy, yellowish, turning somewhat brown. The rough stage is dry and finely wrinkled.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Acid with ammoniacal nitrogen from arabinose, xylose, glucose, fructose, galactose, mannose, sucrose, salicin, glycerol and mannitol; usually also from maluse and raffinose. Reaction variable with dextrin. Usually no acid from rhamnose, lactose, and inulin.

Acetylmethylcarbinol produced.

Citrates utilized as sole source of carbon.

Optimum temperature about 30°C.

Maximum temperature allowing growth usually about 50°C.

Aerobic.

Source: Isolated from plants, cheese, dust, and as a contaminant of media.

Habitat: Widely distributed in nature.

 Bacillus coagulans Hammer. (Iowa Agric. Exp. Station, Research Bull. 19, 1915, 129; Sarjes and Hammer, Jour. Bact., 23, 1932, 301.) From Latin coagulans, curdling, coagulating.

Synonyms: Bacillus thermoacidurons Berry, Jour. Bact., 25, 1933, 72; Bacillus deztrolacticus Andersen and Werkman, Iowa State Coll. Jour. of Sci., 14, 1949, 187

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Spores: Ellipsoidal to cylindrical, terminal or subterminal, thin nalled, 06 to 09 by 1.0 to 1.5 microns. Sporulation better on acid proteose peptone agar (Stern, Hegarty, and Williams, Tood Research, 7, 1942, 185). Sporangia: Only slightly swollen, if at all

Rods: 0 5 to 0 9 by 2.5 to 3 microns, singly or in short chains, resemble Bacillus subtilis. Cells from glucose agar contain few small fat globules Mottle Gram-positive.

Gelatin No growth at 20°C No change in gelatin by Frazier method at 45°C.

Agar colonies: Small, entire, raised, not characteristic.

Agar slants. Grow th scant to moderate, thin, flat. On acid proteose peptone agar growth is more abundant and microscopically the cells appear healther

Broth Moderate uniform turbidity, followed by clearing Glucose broth attains a pH of 4 0 to 4 4

Milk: Coagulated Milk agar plate. Weak hydrolysis of

easem Potato: Growth scant to moderate,

thin, spreading, white to cream-colored May have a sour odor.

Nitrites usually not formed from nitrates.

Starch is hydrolyzed
Acid from glucose, galactose, fructose,

lactose, maltose, sucrose, devtrin, and glycerol. Usually no acid from arabinose and sorbitol No acid from xylose and mannitol Organic nitrogen preferable to inorganic

Acetylmethylcarbinol produced.

Citrates not used as sole source of carbon

Optimum temperature about 45°C (Hammer, 55°C). Mavinum temperature allowing growth 54°C to 60°C Slow growth, if any, at 25°C

Aerobic, facultative

Source Isolated from evaporated milk (Hammer) and tomato juice (Berry). Habitat Canned goods; probably widely distributed in nature.

4 Bacillus firmus Werner. (Cent f.

4 Bacillus firmus Werner. (Cent 1. Bakt, II Abt, 87, 1932, 470) From Latin firmus, firm, strong Spores: Usually ellipsoidal, central to subterminal, 06 to 0.7 by 10 to 12 microns on Ca-n-butyrate agar (Werner); 07 to 09 by 10 to 1.4 microns on nutrient agar. Sporulation better on plain peptone agar than on nutrient agar. Sporangis; Ellipsoidal to evilndrical.

sometimes slightly bulged
Rods 0 6 to 0 by 1 5 to 4.0 microns,
single or in short chains, few filaments
On glucose nutrient agar there are swollen, shadow, and other abnormal forms,
few small fat globules. Motile with

peritrichous flagella Gram-positive Gelatin stab: Slow liquefaction. Gelatin plate shows wide zone of hydrolysis. Agar colonies: Small, smooth, dense.

entire, white to pink.

Agar slants Growth moderate, smooth, opaque, not spreading, whitsh, Pink variations may occur. Growth inhibited when glucose is added, because of the production of acid No growth at pH 60 or below.

Broth Scant uniform turbidity or a

flocculent growth. Milk agar plate: Weak to strong casein

hydrolysis.

Potato: No growth.

Nitrites produced from nitrates Starch is hydrolyzed

Acid from glucose No acid from arabinose and vylose Ammonium salts not used as sole source of nitrogen.

Acetylmethylcarbinol not produced. Citrates usually not utilized

Urease not produced

Salt tolerance Will grow in nutrient broth containing 4 to 7 per cent NaCl Optimum temperature about 28°C.

Maximum temperature allowing growth 37°C to 45°C. Source: Seven strains isolated from

soils in Central Europe and Egypt.

Habitat · Widely distributed in soil.

abitat. Widely distributed in soil.

 Bacillus lentus Gibson. (Cent. f. Bakt., II Abt., 92, 1935, 368) From Latin lentus, slow.

Spores: Ellipsoidal, central to subterminal, 0.7 to 0.8 by 1.0 to 1.3 microns

Sporangia: Ellipsoidal to cylindrical, may be slightly swollen.

glistening, white, opaque.

Rods: 0 6 to 0.7 by 2.0 to 3.0 microns, occurring singly or in pairs. Motile with peritrichous flagella. Gram-positive.

Gelatin stab: No liquefaction, No change in gelatin by Frazier method.

Agar colonies: Small, smooth, entire,

Agar slants: Growth only moderate, slow, thin, gray to white, opaque, not spreading. No growth at pH 6.0 or below, Growth inhibited by glucose because of the change to acid reaction.

Broth Taint uniform turbidity, granular sediment.

Milk: Unchanged.

Milk agar plate: Casein not hydrolyzed,

Potato: No growth,

Nitrites not produced from nitrates.

Starch is hydrolyzed. Acid from arabinose, vylose, glucose,

sucrose, and lactose. Inorganic nitrogen not utilized Acetylmethylcarbinol not formed.

Citrates not used as sole source of

Urease produced. Urea decomposed at room temperature, feebly at 37°C.

Salt tolerance. Will grow in nutrient broth containing 4 per cent NaCl. Optimum temperature about .25°C.

Maximum temperature allowing growth

Growth on most media is increased by the addition of urea

Aerobic.

Nine strains isolated from Source

Habitat · Common in soils.

Bacillus megatherium De Bary. (Bacillus megaterium (sic) De Bary, Vergleichende Morph und Biol. der Pilze, 1884, 499 ) Generally assumed that the original spelling was a typographical error and that the later spelling megatherium comes from Greek roots meaning big animal (Breed, Science, 70, 1929, 480). Rippel (Arch. Mikrobiol., 11, 1940, 470) holds that the original spelling meaning big rod is the correct form.

Synonyms as given by Smith, Gordon, and Clark (loc. cit.): Bacillus capri Stapp, Cent. f. Bakt., II Abt., 51, 1920, 19: Bacillus carotarum Koch, Bot. Zeit., 18. 1888, 277 (Bacterium carotarum Migula, Syst. d. Bakt., 2, 1900, 293); Bacillus cobayac Stapp, Cent. f. Bakt . II Abt., 51, 1920, 10; Bacillus danicus Löhnis and Westermann, Cent. f. Bakt, II Abt., 22, 1908, 253; Bacillus graveolens Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 496 and 535; Bacillus malabarensis Löhnis and Pillai, Cent. f. Bakt. II Abt., 19, 1907, 91; Bacıllus musculi Stapp, Cent f. Bakt., II Abt , 51, 1920, 39: Bacillus oxalaticus Migula, Arb a. d bakt. Inst d. Tech. Hochschule s. Karlsruhe, 1, Heft, 1, 1894, 139; Bacillus petasites Gottheil, Cent. f. Bakt, II Abt., 7, 1901, 535 (Lawrence and Ford, Jour. Bact , 1, 1916, 273); Bacillus ruminatus Gottheil, ibid , 496; Bacillus silvaticus Neide, Cent. f. Bakt., II Abt, 12. 1904, 32; Bacillus tumescens Zopf, Die Spaltpilze, 1 Aufl., 1883, 66 (Zopfiella tumescens Trevisan, Car. d. alc. nuov gen. di Batter., 1885, 4).

Other possible synonyms given by Neide (loc. cit., 11): Bacterium hirlum Henrici, Arb. bakt. Inst. Karlsruhe, 1, 1891, 44 (Pseudomonas hirtum Ellis, Cent f Bakt., II Abt., 11, 1903, 243; Bacillus hirtus Ellis, Ann. Bot., 20, 1906, 233); Bacillus brassicae Pommer, Mitt. botan Inst Graz, 1, 1886, 95 (Bacterium brassicae Migula, Syst. d Bakt., 2, 1900, 296),

Although the name Bacillus tumescens Zopf (which is here regarded as a probable synonym) has priority over Bacillus megatherium, the latter name is preferred because of general usage Neither of the original descriptions is sufficiently detailed to characterize adequately the

nitrates

species named, and Zopf (Die Spaltpilze, 3 Aufi., 1885, 82-83) regarded the two species as distinct. The modern work on which the present description of Bacillus negatherium is based has been largely carried out with cultures identified as Bacillus negatherium, and the true nature of the species is really fixed by the informal emendations made in these more recent descriptions. The emended descriptions give this name a more certain meaning than is given Bacillus tunescens by the descriptions specietation.

Spores: Ellipsoidal, sometimes nearly round, central to paracentral, 1 0 to 1 5 by 1 5 to 2 0 microns (larger dimensions have been remorted)

Sporangia. Ellipsoidal to cylindrical, often in short chains; not swollen

Rods: 12 to 15 by 20 to 40 merons, occurring singly and in short chains Larger and smaller cells, irregular, twisted, and shadow forms are present in some atrains, depending upon the substrate Cells from glucose or glycerol nutrient agar usually store much fat and stain unevenly (vacuolated) with dilute stains. Motility with perturchous flagella, usually slow, although some atrains may show active motility. Gram-positive.

Gelatin stab . Slow liquefaction

Agar colonies Large, smooth, soft, convex, entire, opaque, creamy-white to yellow The rough stage is usually concentrically ridged with a thin edge

Agar slants Growth abundant, soft, butyrous, creamy-white to yellow with pellucid dots Browning with age, a few strains become black if the medium con-

Broth. Medium to heavy uniform turbidity.

Milk, Peptonized

tains tyrosine

Milk agar plate Casein hydrolyzed

Potato: Grow th abundant, smooth, soft to slimy, spreading, creamy-white, pale to lemon-yellow or pink A few strains are orange-colored, some blacken the potato. The rough stage is wrinkled.

Nitrites usually not produced from

Starch is hydrolyzed.

Acid with ammoniacal nitrogen from arabinose, glucose, fructose, sucrose, maltose, dettrin, inulin, salicin, glycerol and mannitol Usually acid from vylose, galactose, mannose, and rafinose; variable from lactose Generally no acid from rhamnose.

Acetylmethylcarbinol not formed,

Uric acid hydrolysis: Variable Optimum temperature 28°C to 35°C. Maximum temperature allowing growth usually between 40°C and 45°C.

Source Originally isolated from cooked cabbage

Habitat. Widely distributed in soil,

Note A description of Bacillus megatherium—Bacillus cereus intermediates follows the description of Bacillus cereus

7 Bacillus cereus Frankland and Frankland (Philosoph Transact. Roy. Soc London, 178, B, 1887, 279.) From Latin cereus, wavy

Synonyms. Bacillus ellenbachenss alpho Stutzer and Hartleb, Cent. f. Bakt, II Abt. 4, 1893, 31; Bacillus ellenbachensus Gotthell, Cent. f. Bakt, II Abt., 7, 1901, 540, Bacterum petroselini Burchard, Arb bakt Inst Karlsruhe, 2, 1898, 39 (Bacillus petrosetini Lehmann and Neumann, Bakt. Diag, 4 Aufl., 2, 1907, 411)

The following are given as possible syronyms by Gottheil, Cent f. Bakt, II Abt, 7, 1901, 540 Bacillus ramosus liquefactens Flügge, Die Mikroorganismen, 2 Aufi, 1886, 342; Bacillus stoloniferus Pohl, Cent. f Bakt., 11, 1823, 142 (Bacterium stoloniferus Chester, Ann. Rept Del Col Agr. Evp. Sta. 9, 1837, 191; Achromobacter stoloniferum Bergey et al, Manual, 1st ed., 1923, 136); Bacillus timetus Russell, Ztechr. f. 11yg., 14.

Spores: Ellipsoidal, central to subterminal, 0.7 to 0.8 by 1.0 to 1.3 microns.

Sporangia: Ellipsoidal to cylindrical, may be slightly swollen.

Rods: 06 to 07 by 2.0 to 3.0 microns, occurring singly or in pairs. Motile with peritrichous flagella. Gram-positive.

Gelatin stab: No liquefaction. No change in gelatin by Frazier method.

Agar colonies: Small, smooth, entire, glistening, white, opaque.

Agar slants: Growth only moderate, slow, thin, gray to white, opaque, not spreading. Nogrowth at plf 6 oer below. Growth inhibited by glucose because of the change to acid reaction.

Broth: Faint uniform turbidity, granular sediment.

Milk · Unchanged.

Milk agar plate: Casein not hydrolyzed

Potate . No growth.

Nitrites not produced from nitrates. Starch is hydrolyzed

Acid from arabinose, vylose, glucose,

sucrose, and lactose Inorganic nitrogen not utilized.

Acetylmethylcarbinol not formed.

Citrates not used as sole source of

carbon.
Urease produced. Urea decomposed at

room temperature, feebly at 37°C
Salt tolerance Will grow in nutrient
broth containing 4 per cent NaCl.

Optimum temperature about 25°C. Maximum temperature allowing growth

Growth on most media is increased by the addition of urea

Aerobic.

Source: Nine strains isolated from soils.

Habitat : Common in soils.

6. Bacillus megatherium De Bary. (Bacillus megaterium (sic) De Bary, Vergleichende Morph und Bol der Pilze, 1884, 499.) Generally assumed that the original spelling was a typographical error and that the later spelling

megatherium comes from Greek rods meaning big animal (Breed, Science, 70, 1929, 480). Rippel (Arch. Mikrobist, 11, 1940, 470) holds that the orignal spelling meaning big rod is the correct form.

Synonyms as given by Smith, Gordon, and Clark (loc. cit.): Bacillus capri Stapp, Cent. f. Bakt . II Abt . 51, 1920. 19; Bacıllus carotarum Koch, Bot. Zeit., 18. 1888, 277 (Bacterium carolarum Migula, Syst d. Bakt , 2, 1900, 293); Bacillus cobayac Stapp, Cent. f. Bakt , II Abt., 51, 1920, 10; Bacillus danicus Löhnis and Westermann, Cent. f. Bakt, II Abt., 22, 1908, 253; Bacellus graceolens Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 496 and 535; Bacillus malabarensis Lohnis and Pillai, Cent. f. Bakt., II Abt , 19, 1907, 91; Bacillus musculi Stapp, Cent. f. Bakt., II Abt , 51, 1920, 39; Bacillus oxalaticus Migula, Arb. a. d. bakt. Inst. d. Tech. Hochschule z Karlsruhe, 1, Heft, 1, 1894, 139; Bacillus petasites Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 535 (Lawrence and Ford, Jour. Bact., 1, 1916, 273); Bacillus ruminatus Gottheil, ibid., 496; Bacillus silvaticus Neide, Cent. f. Bakt., II Abt., 12, 1904, 32; Bacillus tumescens Zopt, Die Spaltpilze, 1 Aufl., 1883, 66 (Zopfiella tumescens Trevisan, Car. d. alc. nuov. gen. di Batter., 1885, 4).

Other possible synonyms given by Neide (loc. cit., 11): Bacterium hirtum Henrici, Arb. bakt. Inst. Karlsrübe, I. 1891, 44 (Pseudomonas hirtum Ellis, Cent f Bakt., II Abt., 11, 1903, 243, Bacillus hirtus Ellis, Ann. Bot, 29, 1965, 233); Bacillus brassicae Pommer, Mitt botan. Inst. Graz, 1, 1886, 95 (Bacterium brassicae Migula, Syst d Bakt., 2, 1906, 296)

Although the name Bacillus tumescens
Zopf (which is here regarded as a probable
synonym) has priority over Bacillus
megatherium, the latter name is preferred
because of general usage. Neither of the
original descriptions is sufficiently detailed to characterize adequately the

species named, and Zopf (Die Spaltpilze, 3 Aufl , 1885, 82-83) regarded the two species as distinct. The modern work on which the present description of Bacultus megatherum is based has been largely carried out with cultures identified as Baciltus megatherum, and the true nature of the species is really fixed by the informal emendations made in these more recent descriptions. The emended descriptions give this name a more certain meaning than is given Bacillus tumescens by the descriptions existent in the literature.

Spores: Ellipsoidal, sometimes nearly round, central to paracentral, 10 to 15 by 15 to 20 microns (larger dimensions have been reported).

Sporangia. Ellipsoidal to cylindrical, often in short chains; not swollen.

Rods 1.2 to 1.5 by 2.0 to 4.0 microns, occurring singly and in short chains Larger and smaller cells, irregular, twisted, and shadow forms are present in some strains, depending upon the substrate. Cells from glucose or glycerol nutrient agar usually store much fat and stain unevenly (vacuolated) with dilute stains. Motility with perturchous flagella, usually slow, although some strains may show active motility. Gram-positive.

Gelatin stab Slow liquefaction.

Agar colonies Large, smooth, soft, convex, entire, opaque, creamy-white to yellow The rough stage is usually concentrically ridged with a thin edge

Agar slants. Growth abundant, soft, butyrous, creamy-white to yellow with pellucid dots. Browning with age; a few strains become black if the medium contains tyrosine.

Broth: Medium to heavy uniform turbidity.

Milk Pentonized

Milk agar plate: Casem hydrolyzed Potato Growth abundant, smooth, soft to slimy, spreading, creamy-white, pale to lemon-yellow or pink A few strains are orange-colored, some blacken the potato. The rough stage is winkled.

nitrates
Starch is hydrolyzed

Acid with ammoniacal nitrogen from arabinose, glucose, fructose, sucrose, mallose, dextrin, inulin, salicin, glycerol and mannitol. Usually acid from xylose, galactose, mannose, and raffinose, variable from lactose Generally no acid from rhamnose

Acetylmethylcarbinol not formed.
Citrates used as sole source of carbon.

Uric acid hydrolysis: Variable.

Ontimum temperature 28°C to 35°C.

Maximum temperature allowing growth usually between 40°C and 45°C.

Source Originally isolated from cooked cabbage.

Habitat Widely distributed in soil, water, and decomposing materials.

Note A description of Bacillus megatherium—Bacillus cereus intermediates follows the description of Bacillus cereus.

7 Bacilius cereus Frankland and Frankland. (Piulosoph Transact. Roy. Soc London, 178, B, 1887, 279) From Latin cereus, wavy

Synonyms Bacillus ellenbacheuss alpha Stutzer and Hartleb, Cent. f. Bakt.,
II Abt. 4, 1898, 31; Bacillus ellenbachensıs Gottheli, Cent. f Bakt., II Abt., 7,
1901, 549; Bacierum petroselini Burchard, Arb bakt. Inst. Karlsrube, 2,
1898, 39 (Bacillus petroselini Elmana)
and Neumann, Bakt Diag, 4 Aufl., 2,
1907, 441)

The following are given as possible syronyms by Gottheil, Cent. f. Bakt, II Abt, 7, 1901, 510 Bacillus ramesus liquefacents Hügge, Die Mikronganusnen, 2 Aufl, 1885, 812; Bacillus statomi-frenz Bohl, Cent. f Bakt, 11, 1822, 112 (Bacterium stoloniferus Chester, Ann. Rept Del. Col Agr. Exp Sta, 9, 1827, 01; Ackromobacter stoloniferum Bergge et al., Manual, 1st ed., 1023, 130; Bactilus henous Russell, Zischt. f. Hyg., 14.

1892, 196 (not Bacillus limosus Klein, Ber. d. deutsch. bot. Gesellsch. 7, 1889, 65; Bacıllus limophilus Migula, Syst. d. Bakt., 2, 1900, 550); Bacillus brevis o Flugge, Ztschr. f. Hyg., 17, 1894, 294; Bacillus lutlentus Kern, Arb. bakt. Inst. Karlsruhe, 1, 1897, 402; Bacillus goniosporus Burchard, Arb. bakt. Inst. Karlsruhe, 2, 1898, 14; Bacterium Inst. Karlsruhe, 2, 1898, 14; Bacterium Lugescens Burchard, ibid., 18; Bacillus cursor Burchard, ibid., 25; Bacillus lozous lozous Burchard,

The following are also listed as synonyms or biotypes of Bacillus cereus by Smith, Gordon and Clark: Bacillus sessilis Klein, Cent. f. Bakt., 6, 1889, 349 and 377 (Bacterium sessile Migula, Syst. d. Bakt., 2, 1900, 290); Bacillus albolactis Migula, thid, 577 (Bacillus lactis albus Loeffler, Berlin, klin, Wchnschr., 1887, 630); Bacillus lacticola Neide, Cent. f. Bakt., II Abt., 12, 1904, 168 (Bacillus No. V. Flugge, Ztschr. f. Hyg., 17, 1894. 294; Bacillus lactis No. V, Kruse, in Flugge, Dic Mikroorganismen, 3 Aufl., 2, 1896, 208; Bacterium lacticola Migula, Syst. d. Bakt., 2, 1900, 305; Bacillus excurrens Migula, soid, 582; Bacillus cereus Chester, Man Determ. Bact., "" . . . . . Wrankland

337 (Bacillus No I, Flügge, Ztschr. f. Hyg., 17, 1894, 294; Bacillus flüggei Chester, Manual Determ. Bact., 1901, 281); Bacillus robur Neide, Cent. f. Bakt , II Abt., 12, 1904, 18; Bacillus thuringiensis Berliner, Zeit. f. angew. Entomol., 2, 1915, 29 (see also Mattes, Gesellschaft zur Beford. der Gesam. Naturw , 63, 1927, 381; Bacterium thuringiensis Chorine, Internat. Corn Borer Invest., 2, 1929, 50); Bacillus cereus var. fluorescens Laubach, Jour. Bact , 1, 1916, 508 (Bacillus fluorescens Bergey et al , Manual, 1st ed., 1923, 298; not Bacillus fluorescens Trevisan, I generi e le specie delle Batteriaces, 1889, 18), Bacillus subtilis Michigan strain, Conn., Jour Inf. Dis , 46, 1930,

341; Bacillus undulatus den Dooren de Jong, Cent. f. Bakt., I Abt., Orig., 122, 1931, 277 (see also den Dooren de Jong. Arch. f. Alikrobiol , 4, 1933, 30); Bacillus siamensis Siribaed, Jour. Inf. Dis., 57, 1935, 143 (see also Bacillus cereus var. siamensis Clark, Jour. Bact., 33, 1937, 435); Bacillus meticns Chatlton and Levine, Iowa Eng. Evp. Station, Bull. 132, 1937, 18; (see also Levine, Bull. 132, 1937, 18; (see also Levine, Bull. 132, 1937, 193); Bacillus tropicus Jour. Sci., 1, 1927, 379); Bacillus tropicus Heaslip, Med. Jour. Australia, 28, 1911, 536.

Neide (loc. cit.) gave the following as possible synonyms of Bacillus lacticola. Bacıllus butyricus Hueppe, Mitteil. a. d kaiserl. Gesundheitsamte, 2, 1884, 309; not Bacillus butyricus Mace, Traité de Bact., 1st ed., 1888 (Clostridium butyricum Prazmowski, Untersuchungen über die Entwickelungsgeschichte und Fermentwirkung einiger Bacterien-Arten Inaug. Diss., Leipzig, 1880, 23); Bacillus aureus Pansini, Arch. f. pathol. Anat. u. Physiol., 122, 1890, 436 (not Bacillus aureus Frankland and Frankland, Philos Trans. Roy. Soc. London, 178, B, 1887, 272); Bacillus lacteus Migula, Syst. d Bakt., 2, 1900, 571 (No. 17, Lemble, Arch f. Hyg., 29, 1897, 323); Bacillus ganiosporus Burchard, loc. cit.

Neide also gave the following as possible synonyms of Bacillus lactis: Bacillus lutulentus Kern, loc. cit.; Bacillus orgomeratus Migula, Syst. der Bakt. 4. 1900, 557; Bacillus amarifeans Mugula, tbid., 584; Bacillus cylindrosporus Burchard, Arb. bakt. Inst. Karlsruhe, 2. 1988, 31.

Other possible synonyms of Bacillus cereus are: Bacillus anthracoides Hoppe and Wood, Ber. klin. Wehnschr., 16, 1889, 347 (Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1890, 223 [and terium anthracoides Migula, Syst. der Bakt., 2, 1900, 231; not Bacterium archracoides Trevisan, I generi e le specie delle Batteriace, 1889, 20); Bacillus pseudanthracis Wahrlich, Bakteriol. Studien, Petersburg, 1800-01, 26 (not

Bacillus pseudanthracis Kruse, in Flegge, Die Mikroorganismen, 3 Aufl. 2, 1896, 233, Bacternum pseudoanthracis Migula, loc. cti, 282); Bacternum flezile Burchard, Inaug., Dws., Karlsruhe, 1973 and Arb bakt Inst Karlsruhe, 2, 1898, 16; Bactlus ellenbach Sawamura, Tokyo Imp. Univ Coll. Agr. Bull. 7, 1906, 105, Bactlus hopkosternus Paillot, Compt rond. Acad. Sci, Paris, 182, 1916, 772; Bactlus hopkinnans Schure and Greenfield, Trans. Roy. Soc. So Africa, 17, 1992 200

Spores Ellipsoidal, average size 1 0 by 1.5 microns (considerable variation has been noted by various writers), central or paracentral, usually freely formed in 24 hours. Germination prevailingly rolar

Sporangia: Ellipsoidal or cylindrical, only slightly swollen, if at all In short to long chains.

Rods: 10 to 12 by 30 to 50 microns, occurring in long chains, ends square Cells appear granular or foamy if lightly stamed, especially if grown on glucose or glycerol nutrient agar; fat usually stored Smooth strains are motile with many peritrichous flagella, rough strains weakly motile or non-motile Gram-nositive

Gelatin stab: Rapid liquefaction

Agar colonies: Large, flat, entire or irregular, whitish with characteristic appearance by transmitted light described by various observers as ground glass, more sulk, or galvanized iron All stages occur from the thin, spreading, very rough and arborescent, to the smooth dense form of colony

Agar slant Growth abundant, usually non-adherent, spreading, dense, whitish to slightly yellowish. Old slants show characteristic whip-like outgrowths Some strains produce a yellowish-green fluorescence

Broth Heavy uniform turbidity, with or without a fragile pellicle

or without a fragile pellicle

Milk. Rapid peptonization, with or
without slight coagulation.

Blood scrum, Partially liquefied, Hemolysis on blood agar. Potato: Growth abundant, thick, soft, creamy-white to pinkish, spreading over the potato. Rough strains may be folded and more piemented.

Nitrites usually produced from nitrates.

Starch is hydrolyzed.

Acid (with ammonacal nitrogen) from glucose, fructose, maltose, dextrin, and glycerol Acid usually from sucrose and salicin. Usually no acid from mannose and lactose No acid from arabinose, rhamnose, xylose, raffinose, inulin, and mannitely.

Acetylmethylcarbinol produced.

Citrates usually utilized as sole source of carbon

Optimum temperature about 30°C. Maximum temperature allowing growth varies from 37°C to 48°C, usually about 43°C.

Aerobic.

Source: From soil, dust, milk, plants, and as contaminant of media

Habstat. Widely distributed. Occurs more often in soil than any other member of the genus. See Chester, Del. Agr. Lap Station, 15th Ann. Report, 1903, 73; Lawrence and Ford, Jour. Bact., 1, 1916, 284; Conn, N. Y. Lup Station, Tech. Bull. SS, 1917; Conn and Breed, Jour. Bact., 4, 1919, 273, Sornano, Thess, Univ Bucnos Aires, 1935, 569.

## Bacillus megatherium-Bacillus cereus intermediates

According to Smith, Gordon, and Clark (loc cit) intermeduate forms occur between Bacillus wegatherum and Bacillus cereus which cannot be represented by a distinct species. These intermediates are characterized morphologically by the early appearance on agar of shadow or distorted forms, long filaments, and generally only a few spores. Fat globules are smaller and less numerous. Physiologically the group is erratic, showing a progression of characters from Bacillus megatherum on the one hand to Bacillus cereus on the other. Acetylmethylcarbi-

nol and nitrites are not usually formed. Fermentation of the pentoses and mannitol, the ability to grow well on glucose nitrate agar, susceptibility to the bacteriophage active against Bacillus megatherium or Bacillus cereus and the general character of the growth determines whether the intermediate is more closely related to Bacillus megatherium or to Bacillus cereus.

Bacillus cohaerens Gottheil (Cent. f. Bakt., II Abt., 7, 1901, 458 and 689) may be taken as a representative of this intermediate group resembling Bacillus megatherium more closely than Bacillus cereus. Gottheil gave as possible synonyms: Bacillus vermicularis Frankland and Frankland, Ztschr. f. Hyg., 6, 1889. 384 (Bacterium vermiculare Migula, Syst. d. Bakt., 2, 1900, 302); Bacillus filiformis Tils, Ztschr f. Hyg., 9, 1890, 293; Bacıllus lactis albus Eisenberg, Bakt Diag., 3 Aufl., 1891, 110; Bacillus virgalus Kern, Arb. bakt. Inst. Karlsruhe, 1, 1897, 416; Bacillus cylindrosporus Burchard, Arb. bakt. Inst Karlsruhe, 2, 1898, 31; Bacillus bipolaris Burchard, ibid , 34.

Other strains which apparently belong to this same group are: Bacterium pansinii Migula, Syst. d. Bakt, 2, 1900, 303 (Bacillus No. 3, Pansini, Arch. f. path. Anat., 122, 1890, 489; Bacterium granulum Chester, Man. Determ. Bact., 1901, 1891; Bacterium tomentosum Henrici, Arb bakt Inst Karlsruhe, 1, 1897, 40; Bacillus teres Neide, Cent f. Bakt., II Abt., 12, 1904, 161.

Representing those strains in this intermediate group more closely related to Bacillus cereus is Bacillus simpler Gottheil (loc. cit., 635). Gottheil gave the following as possible synonyms: Bacillus vacuolosis Sternberg, Manual of Baci, 1893, 717; Bacillus natans Kern, Arb. bakt Inst Karlsrube, 1, 1897, 413; Bacillus loxosporus Burchard, Arb. bakt. Inst Karlsrube, 2, 1898, 49

7a. Bacillus cereus var. mycoides (Flügge) comb. nov (Bacillus mycoides Flügge, Die Mikroorganismen, 2 Auß, 1886, 324.) From Greek mykes, fungus; eidos, form, shape, i.e., fungus-like

Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 589, gave the following as probable synonyms: Wurzelbacillus, Eisenberg, Bakt. Diag., 1st ed., 1886, 4; Bacillus figurans Crookshank, Manual, 1st ed. 1886 (Bacterium figurans Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 134); Bacillus brassicae Pommer, Mitt a. d. hotan. Inst. zu Graf, 1, 1886, 95 (Bacterium brassicae Migula, Syst. d. Bakt., 2, 1900, 296); Bacterium casci Migula, Syst. d. Bakt., 2, 1900, 304 (Bacillus No. XVI, Adametz, Landw. Jahrb., 18, 1889, 248; Bacterium proteum Chester, Man. Determ. Bact., 1901, 195); Bacillus ramosus Frankland and Frankland, Ztschr. f. Hyg., 6, 1889, 388 (not Bacillus ramosus Veillon and Zuber, Arch. Méd. Exp. et Anat Path, 10, 1898, 542); Bacıllus radicosus Zimmermann, Die Bakterien unserer Trink- u Nutzwasser, etc., I Reibe, 1890, 30 (Bacterium radicosum Migula, Syst. d. Bakt., 2, 1900, 253); Bacillus implexus (Bacterium im-Zimmermann, ibid plexum Migula, ibid., 298); Bacıllus intricatus Migula, sbid., 516 (Cladothrix intricata Russell, Ztschr. f. Hyg., 11, 1802, 191).

Another possible synonym is Bacillus praussnitzii Trevisan (I generi e le specie delle Batteriace, 1859, 20). Laubach, Jaur. Bact., 1, 1916, 495, found that this differed from Bacillus mycoides only in the fermentation of lactose. This has

the later nork.

Abt, es of d by four only yariations of Bacillus mycomes amillus

effusus, Bacillus olfactorius, Bacillus nanus and Bacillus dendroides (not Bacillus dendroides Thornton, Ann. Appl. Biol, 9, 1922, 247).

Bacillus cereus var mycoides is identi-

cal in all respects with Bacillus cereus except in the following characters:

Ager colonies Gravish thin widely enreading by means of long twisted chains of cells, turning to the right or left.

Agar slants: Growth thin thirnid. gravish widely spreading, adhering to or growing into the agar. Later, growth becomes thicker and softer.

The physiological similarity between Racellus cereus and Racellus mucardes has often been noted Gordon (Jour Bact . 39, 1940, 98) showed that the rhizoid character of the growth of Bacil-In mucades was readily lost by cultivation in flasks containing 100 ml of broth and that the resulting dissociants could not be differentiated from Bacillus cereus. It is, therefore, a question whether Bacillus mycoides should be given the dignity of a variety of Bacillus cereus or merely designated as a stage of growth (morphotype).

Source: Isolated from soil.

Habitat . Widely distributed in soil

8 Bacillus anthracis Cohn emend (Les infusories de la maladie charbonneuse, Davaine, Compt. rend. Acad Sci., Paris, 69, 1864, 393; Cohn, Beitrage z Biol d Pflanzen, 1, Heft 2, 1872, 177; Koch, sbid . 2, Heft 2, 1876, 279 : Bactéridie des charbon, Pasteur and Joubert, Compt. rend. Acad. Sci., Paris. 84, 1877, 900; Bacterium anthracis Zopf. Die Spaltpilze, 2 Aufl., 1884, 45. Bacillus (Streptobacter) anthracis Schmeter. Kryptogamen Flora v. Schlesien, 3, 1, 1886, 163, Pollendera anthracis Trevisan. 1884, see Trevisan, I generi e le specie delle Batteriacce, 1889, 13, Bactersum anthracis Migula, in Engler and Prantl. Die naturlichen Pflanzenfam, 1, 1a, 1895, 21; Aplanobacter anthracis Erw. Smith, Bacteria in Relation to Plant Diseases, 1905, 171; Bacillus (Bacteridium) anthracis Buchanan, Jour. Bact 5. 1918, 37.) From Greek, gen. of anthrax, charcoal, a carbuncle, the disease anthray.

According to Smith, Gordon, and Clark flor cit ) this energies is a nothogonia variety of Racillus cereus They worked extensively with the latter but not with many strains of Racellus anthrons only difference between the two seemed to be nathogenicity and motility, and some strains of Racillus cereus are weakly nathogenic and some practically nonmotile It would appear that Bacillus cereus is a so-called parent species from which two varieties (var anthracis and var. mucaides) and several mornho, and biotypes have spring.

Spores: Ellinsoidal, 0.8 to 1.0 by 1.3 to 1.5 microns, central or paracentral, often in chains. Germination polar.

Sporangia: Ellipsoidal to evlindrical. not swollen, in chains, Rods - 1.0 to 1 3 by 3 to 10 microps with

square or concave ends, occurring in long chains, resemble Bacullus cereus. Cells from glucose or glycerol putrient agar appear granular (vacuolated) if stained lightly : many fat globules present. Nonmotile, Gram-positive

Gelatin stab. Arborescent in denth. inverted pine tree Liquefaction crateriform becoming stratiform.

Agar colonies: Large, arregular, dense, curled structure composed of parallel chains, similar to certain strains of Racellus cereus.

Agar slant, Growth abundant, gravish. dense, spreading, with fimbriate borders. Broth: Little or no turbidity, thick pellicle.

Milk. Coagulated, slightly acid, peptonized.

Potato: Growth abundant, spreading, white to creamy.

Nitrates formed from nitrates.

Starch is hydrolyzed.

Acid from glucose, fructose, sucrose, maltose, trehalose, and dextrin. Some strains produce late and slight acidity in glycerol and salicin. No definite fermentation occurs in arabinose, rhamnose, mannose, galactose, lactose, raffinose, inulin, mannitol, dulcitol, sorbitol, inositol, and adonitol (Stein, Vet. Med., 58, 19431.

Acetylmethylcarbinol produced.

Optimum temperature about 35°C. Maximum temperature allowing growth about 43°C.

Aerobic, facultative,

Pathogenic for man, cattle, swine, sheep, rabbits, guinea pigs, mice, etc. Source: From blood of infected animals. Habitat. The cause of anthrax in man.

cattle, sheep and swine.

9. Bacillus polymyza (Prazmowski) Migula. (Clostridium polymyra Prazmowski, Inaug. Diss., Leipzig, 1880, 37; Migula, Syst. der Bakt., 2, 1900, 638; Granulobacter polymyza Beijerinck, K. Akad. Wetenschap., Amsterdam, Sec. 2, 1, 1903, No. 10; Granulobacter polymyxa var. mucosum and var. tenax Beijerinck and Van Delden, Cent. f. Bakt., II Abt., 9, 1902, 13; further description by Gruber, Cent. f. Bakt., II Abt., 14, 1905. 353: Aerobacillus polymyxa Donker, loc. cit, 138) From Greek poly, many or much; myra, slime or mucus.

This and the species immediately following (Bacillus macerans) are sometimes placed in the sub-genus Aerobacillus Donker emend. Kluyver and Van Neil (Donker, Inaug. Diss., Delft, 1926, 138; Kinvver and Van Neil, Cent. f. Bakt., II Abt , 94, 1936, 402; not Aerobacillus Pribram, Jour. Bact . 18, 1929, 374; not Aerobacillus Janke, Cent f. Bakt., II Abt., 80, 1930, 481)

For a study of this group and a review of the literature see Porter, McCleskey and Levine, Jour. Bact., 55, 1937, 163. They give the following as synonyms of Bacillus polymyza: Bacillus asterosporus Migula (Astasia asterospora Meyer, Flora, Erg Bd , 84, 1897, 185, Migula, Syst. der Bakt , 2, 1900, 528, Aerobacillus asterosporus Donker, loc. cit, 141); Bacillus ovoaethylicus Pribram (Bacillus mucoides var. ovosethylicus Wagner, Ztschr. f. Untersuch. d. Nahrungs- u Genussmittel, \$1, 1916, 234; Pribram, Klassifikation der Schizomyceten, Leipzig und Wien, 1933, 86); Bacillus aerosporus Greer, Jour. Inf. Dis., 43, 1928. 508.

Gottheil (Cent f. Bakt., II Abt. 7. 1901, 727) regarded the following as synonyms: Bacillus thalassophilus Russell, Ztschr. f. Hyg., 11, 1892, 190; Bacillus subanaerobius Migula, Syst. der Bakt, 2. 1900, 600.

Bredemann (Cent. f. Bakt., II Abt., 23, 1909, 45) admitted that the organisms. Bacillus asterosporus alpha, Bacillus . dilaboides, and Bacillus clostridioides. named by Haselhoff and himself in an earlier article (Landwirtsch, Jahrh . 35. 1906, 420, 426, 432) were merely variants of Bacillus asterosporus.

The following is usually considered a variety or strain of Bacillus polymuza differing from the latter mainly in the production of a violet pigment on potato and agar in the presence of peptone: Bacillus violarius acetonicus Bréaudat, Ann. Inst. Pasteur, 20, 1906, 874 (Aerobacillus violarius Donker, Inaug. Diss, Delft, 1926, 141).

Also a probable synonym of Bacillus polymyxa is Bacillus amaracrylus Vioscnet (Bacille de l'amertume, Voisenet, Compt. rend. Acad Sci., Paris, 155, 1911, 363; Voisenet, Ann. Inst. Pasteur, 32, 1918, 477; Aerobacillus amaracrylus Donker, loc. cet., 141). The chief character in which it differs from Bacillus polymyza is its ability to dehydrate giveerol with the formation of acrolein

Also a probable variant of Bacillus polymyza is Bacıllus pandora Corbet (Jour. Baet., 18, 1930, 321). The chief characters in which the latter differs from the former are the production of scid without gas from glucose and the lack of diastatic action.

Spores: Ellipsoidal, 1 0 to 1 5 by 1 5 to 2.5 microns, central to subterminal, wall usually thick and stainable. Freely formed.

Sporangia Snollen, spindle-shaped (clostridia), sometimes elavate.

Rods 06 to 10 by 25 to 60 microns,

occurring singly or in short chains. Cells contain small fat globules when grown on glucose nutrient agar. Motile with peritrichous flagella Gram-variable.

Gelatin stab: Slow liquefaction. Hydrolysis of gelatin always positive by Frazier technic.

Agar colonies: Thin, inconspicuous, lobed, spreading over entire plate Rough forms are round, whitish, and sometimes tough.

Agar slant. Growth scant to moderate, indistinct to whitish. On glucose agar, the growth is much heavier, raised, supply, clustering; gas is formed.

gunmy, glistening; gas is formed.

Broth: Uniform to granular turbidity, floculent to slimy sediment Rough stage forms pellicle Final pH of glucose

broth cultures 5 2 to 6 8.

Milk Not coagulated, gas usually formed

Milk agar plate Casein hydrolyzed
Potato Growth moderate to abundant,
whitish to light tan, potato decomposed
with formation of gas Growth of rough

stains is denser and heaped up.

Nitrites are produced from nitrates

Stand is hydrolyzed. Crystalling des

Starch is hydrolyzed. Crystalline dextrins are not produced.

Acid and gas (with ammoniacal nitrogen) from arabinose, xylose, glucose, fructose, galactose, mannose, maltose, sucrose, lactose, trehalose, cellobiose, raffinose, melezitose, dextrin, inulin, salicin, glycerol, and mannitol. Gum is also usually formed. Erythritol, adonitol, dulcitol and inositol not fermented. With organic nitrogen no acid or gas from rhamnose or sorbitol (Porter, McCleskey, and Levine, loc. cit., also Tilden and Hudson, Jour Bact., 43, 1942, 530) This, however, could not be confirmed by Smith, Gordon, and Clark (loc. cit ) who found that acid and gas were produced from both carbohydrates.

Hemicellulose and pectin are attacked (Ankersmit, Cent. f. Bakt., I Abt., Orig , 40, 1905, 100). In glucose broth, ethyl alcohol and butylene-glycol are produced also small amounts of acetone and butyl alcohol.

Acetylmethylcarbinol is produced. Citrates usually not utilized as sole

Citrates usually not utilized as sole source of carbon

Optimum temperature about 30°C. No growth at 42°C to 45°C; good growth at 20°C, slow at 13°C.

Not agglutinated by Bacillus macerans sera, results with homologous sera irregular (Porter, McCleskey, and Levine, loc. cit).

Aerobic, facultative

Source: First isolations were from grain, soil, and pasteurized milk

Habitat · Widely distributed in water, soil, milk, feces, decaying vegetables, etc.

In addition see: Chester, Del. Agr Exp. Station, 15th Ann. Report, 1903, 65; Wund, Cent. f. Bakt., I Abt., Orig, 42, 1906, 193, 289, 385; Wahl, Cent. f. Bakt., II Abt., 16, 1906, 489; Ritter, Cent. f. Bakt., II Abt., 29, 1903, 21; Meyer, Cent. f. Bakt., I Abt, Orig., 49, 1909, 305; Bredemann, Cent. f. Bakt., II Abt., 25, 1909, 41; Virtanen and Kurstom, Biochem Zischr, 161, 1925, 9; Stapp and Zycha, Arch. f. Mikrobiol., 2, 1931, 493; Zycha, Arch. f. Mikrobiol., 5, 1932, 194; Patrick, Iowa State Coll Jour. Sci., 7, 1933, 407.

10. Bacillus macerans Schardinger, (Rottebazillus 1, Schardinger, Wieser kin. Wochenschr., 17, 1904, 207; Schardinger, Cent. f. Bakt., II Abt., 14, 1905, 772; Aerobacillus macerans Donker, Inaug. Diss., Delft, 1926, 130; Zymobacillus macerans Kuyver and Van Niel, Cent f Bakt. II Abt., 24, 1936, 402) From Latin macerans, softening, maceratung or rettine.

Porter, McCleskey, and Levine, Jour Bact., 33, 1937, 163, regard the following as a synonym of Bacillus macerans: Bacillus acetoethylicum Northrup, Ashe, and Senior, Jour. Biol. Chem., 39, 1919, I (Aerobacillus acetoethylicus Donker, loc. ctt.).

The following is probably a variant of

Bacillus macerans: Aerobacillus schuylkilliensis Eisenberg, Jour. Amer. Water Works Assoc. 34, 1912, 365. It is said to differ from Bacillus macerans in that sorbitol is not fermented, hydrogen sulfide is produced and gelatin is liquefied.

Spores: Ellipsoidal, 1.0 to 1 5 by 1.5 to 2.5 microns, terminal to subterminal; wall

thick and stainable.

Sporangia: Swollen terminally, clavate. Rods: 9 6 to 1.0 by 2.5 to 60 microns, occurring singly or in pairs, cells are larger on sugar media than on sugar-free media, and contain a few small fat globules. Motile. Gram-variable.

Gelatin stab: Liquefaction variable (see optimum temperature). Gelatin is hydrolyzed as determined by the Frazier technic (30°C).

Agar colonies: Small, thin, transparent to whitish, irregular, usually smooth.

Agar slant: Growth moderate, spreading, inconspicuous.

Broth: Turbid, slight sediment. In sugar broths some strains produce slime.

Glucose broth cultures, pH 50 to 5.5.

Milk: Acid and gas. No visible

peptonization.

Milk agar plate Casein not hydrolyzed in one week; later usually slight hydrolysis

Potato: Growth indistinct, gas is formed and the potato is digested.

Fruity odor sometimes produced.

Nitrites produced from nitrates.

Starch is hydrolyzed.

Acid and gas from arabinose, rhamnose, xylose, glucose, fructose, galactose, mannose, sucrose, maltose, lactose, trehalose, cellobiose, raffinose, melezitose, deatrin, inulin, salicin, peetin, xylan, glycerol, unannitol, and sorbitol. Erythrilol, adonitol, dulcitol, and mositol not fermented (Porter, McCleskey, and Levine, loc. cit.)

Produces acetone and ethyl but never butyl alcohol; ratio acetone to alcohol is 1:2.

Acetylmethylcarbinol not produced.

Citrates not utilized as sole source of carbon.

Optimum temperature about 37°C Good growth at 42° to 45°C and sometimes slightly higher; poor growth, if any, at 20°C.

Differentiated from Bacillus polympra by the production of crystalline destrins from starch, lack of formation of acetyimethylearbinol, and by growth at 42°C to 45°C.

All strains agglutinated by homologous sera but not by Bacillus polymyza serum. Aerobic, facultative.

For additional literature, see Porter, McCleskey and Levine, Jour. Bact., 55, 1937, 180.

Source: Originally isolated from vats in which flax was retting.

Habitat: Widely distributed in soil, water, decomposing starchy materials, retting flax, etc.

11. Bacillus circulans Jordan. (Jordan, Exp. Inv., Mass State Board Health, Part II, 1809, 381; Bactenua circulans Chester, Ann. Rept. Del Col. Agr. Exp. Sta., 9, 1807, 92, also see Ford, Jour. Bact., 1, 1916, 519.) From Latin circulans, making round or circulars.

circular. Smith, Gordon, and Clark (loc cit.) consider Bacillus circulans as a complex (see also Gibson and Topping, Soc. Agric. Bact. (British), Abstr. Proc., 1938, 43) because of the variations in the character of the growth and quantitative differences in physiology. All stages of growth may be found from the smooth actively motile strains that have motile colonies to the mucoid, non-spreading strains The species is more saccharolytic than proteolytic, considerable variation being found in its action on gelatin and casein. The following are regarded as variants: Bacillus closteroides Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1928, 93; Bewegungstypus schwarmender Bakterien, Russ-Munger, Cent. f. Bakt., I Abt., Orig., 142, 1938, 175; Bacillus krzemieniewski

Kleczkowska, Norman and Snieszko, Soil Sci . 49, 1940, 185 (a mucoid variant).

Also probable variants : Bacıllus platus Soriano, Thesis, Univ. Buenos Aires, 1935, 572: Bacillus naviformis Soriano. ibid . 574 (not Bacillus naviformis Jungano, Comp. rend. Soc. Biol . Paris. 1. 1909, 122)

Spores: Ellipsoidal, 08 to 12 by 11 to 2.0 microns, terminal or subterminal. Snore wall thick and stainable. In some strains spores may be kidney-shaped and remnants of sporangium may adhere.

Sporangia · Swollen terminally, clayate, Rods · 0 5 to 0 9 by 2 0 to 5 0 microns.

sometimes curved, usually occurring singly Cells contain small fat globules when grown on glucose agar. Motile, some strains exceedingly so Gramvariable, usually negative.

Gelatin stab: Slow cone-shaped liquefaction, liquefied portion evaporating (Jordan); no liquefaction (Ford) Gelatin hydrolyzed if tested by the Frazier method.

Agar colonies: Thin, transparent, spreading over entire surface of plate. Often nearly invisible. The colonies of the rougher or mucoid strains are small. entire, whitish, non-spreading

Giant agar colonies If the surfaces of near plates are dried before inoculation with very motile strains, instead of spreading as a thin layer of individual cells, minute rotating colonies proceed out from the edge of the colony, sometimes becoming entirely disconnected from it In moving out across the agar surface, non-motile cells are left behind. These may grow later. Eventually the whole plate is covered.

Agar slant Growth thin, transparent, spreading, becoming denser, Mucoid atrains are dense, non-spreading, entire. gummy and adherent.

Broth, Light to fair turbidity with flocculent to slimy sediment Some strains do not grow perceptibly. In glucose broth cultures the final pH is usually 5 0 to 5.8.

Milk. Usually acid, slowly coagulated. Milk agar plate: Casein not hydrolyzed. Weak hydrolysis with some strains

 Potato . Growth is very variable, from none to good growth, from colorless to vellowish, pink, or brownish.

Nitrites usually produced from nitrates.

Starch is hydrolyzed. Crystalline devtrins usually not formed

Acid without gas (with ammoniacal nitrogen) from glucose, fructose, mannose, galactose, sucrose, maltose, raffinose, salicin, and dextrin Usually acid from arabinose, xylose, lactose, glycerol, and mannitol. Reaction variable with rhamnose and inulin

Acetylmethylcarbinol not produced. Citrates usually not utilized.

Methylene blue reduced and then reavidized

Urease produced by some strains.

Optimum temperature about 30°C. Maximum temperature allowing growth. 40°C to 48°C A few strains will grow up to 52°C

This species is closely related to Bacillus macerans from which it is distinguished by the lack of gas formation from carbohydrates and the lack of crystalline dextrins from starch It is also close to Bacillus alies as indicated by the key.

Source. Found occasionally in tap nater, Lawrence, Mass. (Jordan)

Habitat Widely distributed in soil. water, and dust

12. Bacillus alvel Cheshire Cheyne (Jour. Roy Mic. Soc. Ser. II, 5, 1885, 592.) From Latin alreus, beehive

Probably identical with the above. Bacillus paraaliei Burnside, Amer. Bee Jour , 72, 1932, 433; Burnside and Foster. Jour. Econ Entomol , 28, 1935, 578.

Spores: Ellipsoidal, 0.7 to 1 0 by 1.5 to 25 microns, central to terminal. Free spores frequently lie in parallel arrangement like the mda

Sporangia: Swollen, spindle-shaped to clavate.

Rods: 0.5 to 0.8 by 2 to 5.0 microns. Cells frequently lie parallel, side by side, like cartridges in a clip. Usually non-capsulated and very motile. Few small fat globules in cells from glucose agar. Gram-variable (young cells Gram-positive, becoming Gram-negative).

Gelatin stab: Slow liquefaction.

Agar colonies: Thin, translucent, smooth, quickly spreading as a thin layer over entire plate. The growth thickens with age. Rough and mucoid strains do not spread.

Giant agar colonies: If the surfaces of agar plates are dried before inoculation with the motile atrains, instead of spreading as a thin layer, minute bullet-shaped colonies proceed out from the edge of the colony and move across the sterile agar. Non-motile and sometimes motile cells are left behind along the path made by the motile colony (Smith and Clark, Jour. Bact, 35, 1938, 59). Eventually the whole plate is covered.

Agar slant. Growth thin, inconspicuous, spreading, becoming thicker. Rough

strains may form a pellicle Glucose broth cultures have a pH of 5.0 to 60. Milk: Usually coagulated, little or no acid, peptonized

Milk agar plate Casein hydrolyzed. Potato . Growth seant to moderate, soft,

spreading, usually creamy yellow.

Nitrites not produced from nitrates Starch is hydrolyzed

Acid (with ammoniacal nitrogen) from glucose, fructose, galactose, sucrose, maltose, dextrin and glycerol. Reaction variable on mannose, factose, raffinose, saliein, and manutol. No acid from arabnose, rhamnose, xylose, and inulin. Acetylmethylcarbinol is produced.

Citrates not utilized

Optimum temperature about 30°C.

Maximum temperature allowing growth 43°C to 45°C.

Putrefactive odor on media rich in proteins (egg),

Aerobic.

Source: Isolated from diseased broad of bees.

Habitat: Associated with European foulbrood of honey bees; widely distributed in soil.

Note: The following must be considered in connection with Bacillus also:
Bacillus plutan White. (U. S. Dept.

of Agric., Bur. Entomol., Circ. 157, 1912; Diplococcus pluton Bergey et al., Manual, 2nd ed., 1925, 45)

See also Lochhead, Science, 67, 1923, 169 and Proc. IV Intern. Congr. Entomol, 2, 1929, 1005; Burnside, Jour. Eco Entomol, 27, 1934, 656; Tarr, Ann. Appl. Biol., 24, 1935, 614; Burn, Reihelte r. schweiz. Beinenz., 1, Helt 1, 1941.

White considered Bacıllus pluton to be the cause of European foulbrood though the evidence was indirect since the organism was not cultivated. Lochhead suggested that Bacillus pluton and Streptococcus apis are variants or stages in the life history of Hacillus alvei, a hypothesis supported by Burnside who included, in addition, Bacterium eurydice. According to Burri, rod forms identical with Bacterium eurydice give rise to Bacillus pluton which is not directly cultivable Tarr considers European foulbrood to be caused by Bacillus pluton, distinct from Bacillus alvei, and considers it a strict parasite able to multiply only in the intestines of young larvae.

Source: Larvae of the honey bee infeeted with European foulbrood.

13. Bacillus laterosporus Laubach. (Jour. Bact., 1, 1916, 511.) From Latin latus, lateris, the side; Greek sporus, seed; M.L., spore.

Synonym: Bacillus orpheus White. (U. S. Dept. of Agric., Bur. Entomol., Circ. 157, 1912, 3) Although named by White, the organism was not described until 1917 (McCray, Jour. Agr. Research, 8, 1917, 410). Resembles Bacillus laterosporus (White, U. S. Dept Agric. Bull. 810, 1920, 14). According to the rules of priority, the name to be used is Bacillus laterosporus

Spores. Ellipsoidal, 10 to 13 by 12 to 15 microns, central to subterminal, formed close to one side, remnants of the sporangium adhering to the other side

Sporangia: Swollen, spindle-shaped Rods: 0.5 to 0.8 by 2.0 to 5.0 microns.

Rods · 0 5 to 0.8 by 2 0 to 5 0 microns, occurring singly and in pairs Ends pointed or poorly rounded Cells from glucose nutrient agar may have few small fat globules Motile Gram-varnable.

Gelatin stab · Slow liquefaction

Agar colonies Thin, transparent, irregular, spreading Colonies of rough strains are small, round, convex, nonspreading

Agar slant: Growth moderate, flat, translucent to opaque, moist, sometimes with a silvery sheen

Broth Uniform to granular turbidity, usually no pellicle Glucose broth cultures, pH 6 0 to 6 4.

Milk Usually curdled, peptonized Milk agar plate Occasionally weak hydrolysis of casein

Potato Growth thin, spreading, grayish to pinkish, turning light brown with age Sometimes finely wrinkled.

Nitrites produced from nitrates Starch is not hydrolyzed.

Acid (with ammonacal nitrogen) from glucose, fructose, maltose, glycerol, and mannitol Reaction variable on galactose, mannose, and saliein. No acid from arabinose, rhammose, xylose, sucrose, lactose, raffinose, nuglin, and devtrin.

Acetylmethylcarbinol not produced Citrates not utilized as sole source of

carbon.

Optimum temperature about 28°C
Maximum temperature allowing growth
37°C to 45°C

Aerobic.

Source · Isolated from water Habitat: Widely distributed in soil, water and dust. 14. Bacillus brevis Migula emend Ford. (Bacillus No. I. Flöge, Zischr. I. Hyg., 17, 1894, 294, Bacillus lactis No. I, Kruse, in Tlögge, Die Mikroorganismen, 3 Aufl., 2, 1905, 288, Migula, Syst. d. Bakt., 2, 1900, 583, not Bacillus brevs Frankland and Frankland, Microorganisms in Water, 1894, 429, Bacillus flüggei Chester, Man Determ Bact, 1901, 281; Ford, Jour Bact., 1, 1916, 522) From Latin bretis, short.

Synonym · Bacillus centrosporus Ford, Jour. Bact , 1, 1916, 524.

There is some doubt as to the identity of Manula's Racellus brens which originally was Flugge's Bacillus No. I. Neide (Cent. f. Bakt., II Abt . 12, 1904, 337) also renamed Flitege's organism. He called it Racellus lactic and described it sufficiently that it may be recognized as a strain of Bacillus cereus. Ford believed that his isolations from milk, soil and dust conformed to Migula's description of Bacillus brevis. Ford's interpretation has been accepted The species has annarently become well established in Europe (Gibson and Topping, Soc. Agric. Bact. (British), Abstr. Proc. 1938, 43) as well as in America.

Description from Ford and from Smith, Gordon, and Clark (loc cit.)

Spores. Ellipsoidal, 10 to 13 by 15 to 20 microns, central to subterminal Spore walls thick and stainable. An occasional strain shows the relationship of this species to Bacillus laterosporus in that some of the spores may be lateral and remnants of the sporangia may adhere to one side of the spore.

Sporangia Definitely swollen, spindleshaped to clavate

Rods: 0 4 to 0 8 by 1 5 to 50 microns, with pointed ends, occurring singly or in pairs. On glucose agar cells contain numerous small fat globules. Motile. Gram-variable

Gelatin stab Slow liquefaction.

Agar colonies: Thin, flat, translucent.

smooth, quickly spreading over plate.

Agar slants: Growth smooth, moist,
spreading, gravish white.

only at higher temperatures and under anaerobic conditions. Migula called this Bacillus pseudotetanicus. Ford (Jour. Bact., 1, 1916, 520) stated that this name had priority over Neide's Bucillus sphaericus which he thought was identical. On the other hand, Tayel floc. cit.) isolated a pseudotetanus bacillus that was apparently anaerobic. Its spores were ellipsoidal and it formed more gas than the tetanus bacillus Migula named this organism Bacellus pseudofelani, Subsequently both Migula's names have been applied to the aerobic organism. Bacillus pseudotetanicus and Bacillus pseudotetani are nomina dubia and Bacillus sphaericus should therefore be used.

Spores: Spherical, 0.7 to 13 microns in diameter, terminal to subterminal. Young spores in spotangia may be oval. Spore wall thick; remnants of sporangium may adhere.

Sporangia: Definitely swollen, clavate to spindle-shaped.

Rods: 0 6 to 1.0 by 1.5 to 7.0 microns, occurring singly or in short chains. On glucose agar cells contain few small fat globules. Motile. Gram-variable; often Gram-negative with Gram-positive granules.

Gelatin stab: Scant growth No liquefaction. Gelatin hydrolyzed if tested by the Frazier technic.

Agar colonies: Small, thin, flat, translucent, often spreading over the plate.

Giant agar colonies If the surface of the agar is fairly dry, many strains exhibit minute colonies that swarm out from the point of inoculation and cover the plate (cf. Bacillus circulans).

Agar slants: Growth thin, smooth, spreading, translucent, becoming yellowish-brown Growth occurs at pH 6.0

ish-brown Growth occurs at pH 6.0 Broth: Uniform turbidity. Glucose broth cultures have pH of 8 3 to 8 6 after 7 days

Milk · No change

Milk agar plate Scant, if any, hydrolysis of casein. Potato: Growth scant, thin, spreading, soft, gray, becoming yellowish-brown with age.

Nitrites not formed from nitrates. Starch not hydrolyzed.

No acid from carbohydrates.

Acetylmethylcarbinol not produced. Citrates not utilized.

Urease not formed.

Salt tolerant. Growth occurs in broth containing 4 per cent NaCl.

Optimum temperature about 30°C. Maximum temperature allowing growth 40°C to 45°C.

Not pathogenic for guinea pigs. Aerobic, facultative.

Source: From mud of a pond, rotting cypress wood, rotting oak wood, and from

soil.

Habitat: Widely distributed in nature.

Bacillus rolans Roberts (Jour. Bact,
29, 1995, 229) differs from Bacillus
sphaericus in that it will not grow as low
as pH 6.0 nor in broth containing 4 per
cent NaCl. Originally characterized by
motile colonies, this phenomenon bas
been noted with certain other members
of the genus and with some strains of
Bacillus sphaericus. Smith, Gordon,
and Clark (loc. cit.) consider it a variety
of Bacillus sphaericus shapericus

Source: From intestine of a termite Habitat: Probably widespread in soil

18a. Bacillus sphaericus var. fusiformis comb. nov. (Bacillus fusiformis Gottheil, Cent. f. Bakt, II Abt, 7, 1901, 724.) From Latin fusus, spindle; formis, shape

This organism differs from Bacillus sphericus only in that it produces trease. Source: One strain isolated from Bels sulgaris lutes (beet). Also from milk, dust, soil and contaminated hirudin. Habitat Widely distributed in nature

Bacillus lochnisii Gibson (Jour. Batt., 29, 1935, 493) is very closely related to the above. It will not grow at pil 60 or below, prefers media containing ures, and produces nitrites from nitrate Gibson (loc. cil., 500) in discussing the

organisms of this group stated "each species contains strains dissimilar in several features and each is connected to the others by transitional forms". Smith, Gordon, and Clark (loc cit.) tentatively have placed it as a variety of Bacillus spharericus

Source · From soil.

Habitat: Widely distributed in soil

19 Bacillus pasteurii (Miquel) Chester. (Urobacillus pasteurii Miquel, Ann Micrographie, 1, 1889, 552; sive Bacillus urcace, ibid., 2, 1899, 13, 53, 122, 145, 367, 488; Chester, Ann. Rept Del Col Agr. Exp Sta., 19, 1898, 110) Named for the French scientist, Louis Pasteur (1822-1895)

Vichover, Cent. I Bakt., II Abt, 29, 1913, 209, gave the following as possible synonyms 'Urobacillus maddozu' Miquel, Ann Micrographie, 5, 1891, 275 and 305 (Bacterium maddozi Chester, Ann Ropt Del Col. Agr Exp Sta, 9, 1897, 95; Bacillus maddozi Chester, 1bid, 10, 1898, 110); Urobacillus leubes Beijerinck,

Cent. f Bakt , II Abt , 7, 1901, 51 Synonyms according to Gibson, Jour Bact . 29, 1935, 494 and 496; Bacillus probatus Vichover, Cent f Bakt , II Abt., 1913, 209; Urobacillus psychrocartericus and Urobacillus hesmogenes Rubentschik, Cent f Bakt, II Abt., 66, 1925, 166 (Bacillus psychrocartericus and Bacillus hesmogenes Bergev et al., Manual, 3rd ed , 1930, 403, 404) Gibson also included the following as possibly identical with the above although they were incompletely described · Bacillus urcae II and III Burrs. Herfeldt and Stutzer. Jour Landw., 42, 1891, 329; Urobacillus duclauxu Miquel, Ann Micrographie, 2, 1890. 53, 122, and 145; Urobacillus maddox11 Miquel, 161d , 3, 1891, 275 and 305.

Description taken from Löhnis and Kuntze, Cent. f. Bakt., II Abt., 20, 1908, 681; Gibson, Jour. Bact., 28, 1934, 295 and 313, Smith, Gordon, and Clark (loc. cit.).

This species has been designated as the type species of the genus Urobacillus Miquel (Ann de Micrographie, 1, 1889, 517) by Enlows (U. S. Pub. Health Scr., Hyg. Lab. Bull. 121, 1920, 96).

Spores: Spherical, 10 to 1.2 microns, terminal to subterminal.

Sporangia: Prevailingly clavate. Not in chains.

Rods: 0.7 to 0.8 by 1.5 to 2.0 microns (1.0 to 1.5 by 4.0 to 5.0 microns, Löhnis and Kuntze), occurring singly or in pairs. Motile Gram-variable.

Urea gelatin stab: Slow líquefaction.
Urea agar colonies: Small, entire, not
characteristic.

Urea agar slope. Growth thin, very little spreading, colorless or white to yellowish. Will not grow at pH 60 or less.

Urea broth: Moderate to heavy uniform turbidity. Will grow with 4 per cent NaCl added

Nitrites produced from nitrates in urea nitrate nutrient broth.

Starch not hydrolyzed.

Carbohydrates not attacked.

Acetylmethylcarbinol not formed. Urease produced.

Optimum temperature about 30°C, minimum 6°C. Maximum temperature allowing growth 40°C in water bath. Optimum temperature for urease activity

50°C Aerobic

The distinguishing character of this species is that growth occurs only in peptone media containing urea or free animonia under neutral or alkaline conditions

Source From decomposing urine.

Habitat Widely distributed in soil, dust, manure, and sewage,

20. Bacillus thermoamylolyticus Coolhaas (Cent f. Bakt, II Abt., 75, 1928, 341) From Greek thermos, hot, amylon, starch, and lytikos, able to loose, hence, dissolving Probably intended to mean thermophilic and starch digesting.

Spores: Slightly clongated, ellipsoids 0 6 by 1 5 microns, central

Sporangia: Cylindrical, not swollen, not in chains Rods: 0.6 by 5 to 8 microns. Motile. Gram-positive.

Gelatin stab: No liquefaction.

Agar colonies: At 60°C of two types.

large and small, circular, translucent, granular, slimy.

Broth: Very weak growth, no surface growth, no sediment.

Milk: Not coagulated, slowly peptonized.

Potato: Slight growth.

Nitrites produced from nitrates. Starch actively hydrolyzed.

Acid and gas from glucose, fructose, galactose, maltose, dextrin, starch and glycerol. Arabinose, xylose and manni-

tol not fermented
Thermophilic, optimum temperature
50° to 55°C.

Aerobic.

Source: From sewage.

Habitat: Probably in decaying matter.

21. Bacillus kaustophilus Prickett., (N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1928, 33) From Greek kaustós, burnt, red-hot; zhilos. loving: heat-loving.

Spores: Ellipsoidal, 05 by 06 to 0.8 micron, terminal to subterminal. No free spores observed.

Sporangia: Only slightly swollen if at

Rods: On yeast extract-nutrient agar at 56°C, 07 by 2.0 to 45 microns, with rounded ends. Actively motile. Grampositive.

Gelatin stab: No growth at 20°C. Liquefied at 56°C.

Agar colonies: At 56°C, circular, convex, smooth. Borders entire to irregular. Show curled structure, strands of chains Brown by transmitted light.

Agar slant: Growth abundant, raised, glistening, contoured, bluish-green to bluish-white by transmitted light. After three weeks at 37°C, growth has a distinct reddish-brown color, butyrous, viscid.

Broth. Slightly turbid, no sediment. No surface growth, alkaline.

Litmus milk: Rennet coagulum, peptonization feeble, litmus reduced. Po tato: Amount of growth variable, brownish, spreading, glistening, slimy Some strains do not grow.

Nitrites produced from nitrates, often with the production of nitrogen

Starch is hydrolyzed.

Acid from glucose and salicin. Rhamnose, maltose, sucrose, raffinose, mannitol, sorbitol and inulin not fermented

Acetylmethylcarbinol not produced Thermophilic, optimum temperature

60°C to 65°C. Growth at 73°C to 75°C but none at 80°C on agar slants.

Aerobic, facultative.

Good growth occurs in synthetic media containing potassium nitrate, sodium ammonium phosphate, aspartic acid, and sodium asparaginate, respectively, as only sources of nitrogen with glucose as source of carbon

Source: Forty-eight cultures isolated from pasteurized milk at a single milk plant (Buffalo, N. Y.).

Habitat: Probably originally from soil

Thermobacillus digestans Feirer (Soil Sci., 23, 1927, 50) seems to be closely related to the preceding. It is more strongly proteolytic, digesting milk completely in 7 days.

Source: Four strains isolated from soil.

21a, Bacillus pepo Shaw. (Jour. Inf. Dis., 43, 1928, 473.) From Cucurbita pepo, the pumpkin.

From the brief original description, this organism seems to vary from Bacillus kaustophilus only in its distinctive viscid or slimy character.

Source Two cultures isolated from swelled cans of pumpkin.

Habitat: Probably found in soil and dust.

22. Bacillus thermoindifferens Weinzurl (Jour. Med. Research, 39, 1019, 402.) From Greek thermos, hot and Latin indifferens, maifferent. Indifferent or tolerant of heat.

Spores. Ellipsoidal, 0 5 by 0 8 micron, terminal. Sporangia: Cylindrical, not swollen. Rods: 0.7 by 2.0 to 4 5 microns, occurring singly and in short chains, with rounded ends. Motile. Gram-positive. Gelatin stab: Growth filiform. Slow

Agar colonies Circular, convex, smooth, entire, amorphous Agar slant Growth flat, spreading,

infundibuliform liquefaction.

Agar slant Growth flat, spreading, glistening, translucent, butyrous, contoured.

Broth: Turbid, abundant sediment. No surface growth

Litmus milk: Alkaline Litmus

Potato: No growth.

Indole not formed

Nitrites not produced from nitrates Starch is hydrolyzed.

Acid from glucose No acid from lactose, sucrose or mannitol.

Thermophilic, optimum temperature 55°C Grows at 20° to 37°C.

Aerobic

Source · Isolated from canned pumpkin. Habitat Probably found in soil and dust.

Thermobaculus reductans Ferrer (Soil Sci. 23, 1927, 51) is said to resemble Bacullus thermondifferens except that nitrites are formed from nitrates and the minimum temperature is 40°C.

Source: Two strains isolated from soil Thermobacillus catenatus Feirer (Soil Sci, 23, 1927, 53) may be related to this group. The description is very incomplete. Its distinctive feature is the production of indole

Source Two strains isolated from soil.

23 Bacillus thermodisstaticus Bergey et al. (Type 1, Bergey, Jour Bact., 4, 1919, 301, Bergey et al., Manual, 1st ed., 1923, 310) From Greek thermos, hot and dastatics, separative M. L., enzymatic, diastatic; hence dastatic at high temperatures.

Spores Of less diameter than that of

the rods, ellipsoidal, central
Sporangia: Cylindrical.

Rods: 05 to 07 by 2 to 3 microns,

occurring in chains, with square ends. Motile with peritrichous flagella. Grampositive.

Gelatin stab: Liquefaction.

Agar colonies: Grayish, spreading, with lobate to fimbriate borders.

Agar slant: Growth thin, limited, bluish-gray.

Broth : Turbid.

Litmus milk: Not coagulated, peptonized

Potato: Growth slight, grayish. Nitrites produced from nitrates

Starch is hydrolyzed

Thermophilic, optimum temperature 65°C. No growth at 50°C. Growth at 75°C.

Aerobic.

Source: Isolated from dust and contaminated milk.

Habitat: Probably widely distributed in soil and dust.

Thermobacillus diastassus Feirer (Soil Sci, 23, 1927, 49) differs from Bacillus thermodiastaticus only in that nitrites are not formed from nitrates (Feirer).

Source: Two strains isolated from soil.

24 Bacillus cylindricus Blau. (Cent. f. Bakt, II Abt, 15, 1905, 119) From Greek kylindrikos, cylindrical

Spores: Somewhat elongated, 0.7 to 1 I by 1 8 to 2.5 microns, terminal. Remnants of sporangium adherent. Germination equatorial and oblique

Sporangia Cylindrical or only slightly swollen at end, not in chains

Rods: On glucose agar at 60°C, 0.8 to 11 by 50 to 7.5 microns, occurring singly and in pairs Motile with peritrichous flagella. Cells store glycogen. Gram-positive

Gelatin stab No liquefaction

Glucose agar colonies: Grayish-white, entire to lobed to dentate. By transmitted light yellowish-brown centers with brownish-yellow borders. Finely fibrous structure.

Glucose agar elant: Growth thin, dull, grayish-white.

Litmus milk: Unchanged.

Potato: No growth.

Nitrites not produced from nitrates. Starch not hydrolyzed.

Thermophilic, optimum temperature

Source: Isolated from moist field soil in

Germany.

Habitat: Probably found in dust and

soil.

Bacillus calidus Blau (Cent. f. Bakt..

II Abt., 15, 1905, 134) differs so little from the preceding species that it cannot be considered as distinct.

Source: Isolated from field soil in Germany (Blau). Dust, ground feeds, etc., about dairies and various dairy products (Prickett, N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1928, 45).

25. Bacillus robustus Blau. (Cent. f. Bakt., II Abt., 15, 1905, 126.) From Latin robustus, oaken, hard, firm.

Spores. Ellipsoidal, 1.0 by 1.6 to 2.2 microns, polar to medial. Remnants of sporangium not adherent. Germination prevailingly equatorial.

Sporangia Ellipsoidal to cylindrical,

not in chains.

Rods: 1.0 to 1.2 by 3 to 4 microns, occurring singly and in short chains. Motile. Gram-positive.

Glucose agar colonies. Circular, graywhite. By transmitted light brownishyellow. Borders distinct, serrate to lobed, finely granular.

Glucose agar slant: Growth yellowishwhite, translucent, becoming grayishwhite, spreading, dull.

Potato: Growth yellowish-white, moist,

Nitrites not produced from nitrates. Starch not hydrolyzed.

Thermophilic, optimum temperature 55°C to 60°C. Grows at 65°C.

Aerobic.

Source: Isolated from field soil near a forest in Germany.

Habitat Probably found in soil and dust.

Thermobacillus restatus Feirer (Soil Sci., 23, 1927, 51) is said to correspond

in some respects with Bacillus robustus. Feirer states that it is not possible to definitely establish the identity because Blau failed to record the action of Bacillus robustus on nitrates and several other media and did not note the production of H<sub>1</sub>S.

Source: Three strains isolated from soil.

25a. Bacillus losanitchii Bergey et al. (Bacillus thermophilus losanitchii Georgevitch, Cent. f. Backt., 11 Abt., 27, 1910, 164; Bergey et al., Manual, 1st ed., 1923, 313.) Named for Losanitch, near Vranje.

As far as can be determined from the meager description, this organism does not differ from Bacillus robustus evept perhaps as to the maximum temperature allowing growth. Growth limits are 45°C to 78°C.

Source: Isolated from water of hot sulfur spring. Temperature of water 83°C.

Habitat: Probably in natural hot waters.

Norn: Georgevitch (Arch. f. Hyg., 72, 1910, 201) has described a thermophilic aerobic spore-forming sulfur bacilius from a hot sulfur spring at Vranje (Servia) under the name Bacillus themephilus verayiensis. This does not grow on ordinary media unless sulfur compounds areadded. It has a tutter flagella at either end. Spores are ellipsodal, terminal, distend the rod, and show polar eventuation.

Georgevitch (Cent. f. Bakt., II Abt. gr. 1919, 159) describes a second thermophilic, mottle, capsulated, ellipsoidal-spored rod from a chalybeate hot spring near Vranje under the name Bacillus thermophilus juroini

26 Bacillus calidolactis Hussong and Hammer. (Jour Bact., 15, 1928, 186.) From Latin calidus, warm, hot and laclactis, milk

Gorini states (R. Ist Lombardo Sci. & Lett. Rend , 76, 1942, 3) that Bacillus calidolactis is the same organism as Bacillus lactis termophilus (sie) Gorini (Giorn. d. R. Soc. Ital d'Igiene, 16, 1804, 16). From the descriptions this appears to be probable.

appears to be probable

Spores. Ellipsoidal, of slightly greater
diameter than the rods, terminal

Sporangia: Slightly swollen, clavate Rods 07 to 14 by 26 to 50 microns, occurring singly, in pairs and short chains Non-motile. Gram-positive, some cells becoming Gram-negative with are.

Gelatin stah: No liquefaction

No growth on plain nutrient agar Glucose agar colonies Thin, white,

opaque, filamentous
Glucose agar slant: Growth abundant.

echinate, dull, white
Glucose agar stab. Growth abundant.

beaded, gray

Glucose broth. Turbid

Litmus milk Acid, coagulation. Lit-

Potato: No growth.

Nitrites produced from nitrates by some strains Acid from glucose, lactore, fructose,

galactose and maltose No acid from mulin, sucrose or glycerol.

Thermophilie, optimum temperature 55°C to 65°C No growth at 37°C

Aerobic, facultative

Source Isolated from normal pasteurized shum milk (Hussong and Hammer). Milk and milk powder (Prickett, N Y Agr Exp Sta Tech Bul 147, 1928, 47)

Habitat Probably in dairy products

27 Bacilius michaelisli Prickett (Bacilius thermophilus aquatitis liquefaciens Michaelis, Arch. f. Hyg., 38, 1899, 285; Prickett, N. Y. Agr. Exp. Sta Tech Bul. 147, 1928, 45) Named for Georg Michaelis of Berlin who first isolated the species.

Spores Of greater diameter than the rods, terminal,

Sporangia: Swollen, clavate.

Rods 06 to 0.8 by 2 to 4 microns. Motile Gram-positive. Gelatin stab: Liquefaction,

Agar colonies: Circular, raised, smooth, glistening

Agar slant: Growth moderate, smooth,

Broth. Slight turbidity.

Milk Not congulated alkaline

Potato: Growth moist, glistening, yellowish, becoming brownish

Nitrites with gas produced from

Starch is hydrolyzed.

Acid from glucose and sucrose. No acid from rhamnose, maltose, lactose, glycerol, mannitol or mulin.

Thermophilic, optimum temperature 50°C to 60°C

Aerobic, facultatave

Source. Isolated from fountain waters (Michaelis) From fodder, dust, dairy utensils (Prickett)

Habitat. Probably found in soil and dust

27a Bacillus Iobatus Bergey et al. (Type 3, Bergey, Jour Bact , 4, 1919, 301; Bergey et al , Manual, 1st ed., 1923, 311.) From Greek Iobatos, having the form of a lobe.

Judging from the meager description, there is no essential difference between this organism and the preceding.

Source Isolated from dust, soil, and horse manure.

Habitat: Probably widely distributed in soil and decaying matter.

Bacillus nondiastaticus Bergey et al. (Type 2, Bergey, Jour Bact , 4, 1919, 304; Bergey et al , Manual, 1st ed , 1923, 310) From Greck, no diastase.

The description of this organism is practically identical with Bacillus lobatus, the only difference noted being that this species hydrolyzes starch while Bacillus nondiastaticus does not

Source Isolated from dust and soil (Bergey). Ground grains, raw and pasteurized milk (Prickett, N. Y. Agr. Exp. Sta. Tech. Bul. 147, 1923, 47).

Thermobacillus vulgaris Feirer (Soil Sci , 23, 1927, 50) liquefies gelatin, does not reduce nitrates to nitrites nor alter litmus milk. According to Feirer it is otherwise similar to Bacillus nondiastaticus.

Source: Two strains isolated from soil.

27b. Bacillus thermononliquesaciens Bergey et al. (Type 4, Bergey, Jour. Bact , 4, 1919, 301; Bergey et al., Manual, Bate d., 1923, 312.) From Greek thermos, hot; and Latin non, not and liquespaciens, making liquid. Probably intended to mean thermophilic and non-gelatinliquefying.

Aside from the non-liquefaction of gelatin, there seems to be no difference in the description of this organism and the two immediately preceding.

Source: Isolated from dust, soil, and horse manure.

Habitat · Probably found in soil and decaying matter.

. 28. Bacillus thermotranslucens Bergey et al. (Type 5, var b, Bergey, Jour. Bact, 4, 1919, 304; Bergey et al., Manual, 1st ed., 1923, 312) From Greek thermos, hot and Latin translucens, translucent Probably intended to mean thermophilic and translucent.

Spores: Of larger diameter than the rods, terminal.

Sporangia: Terminally swollen, clavate,

Rods: 03 to 04 by 1.0 to 15 microns, occurring singly. Motile with peritrichous flarella. Gram-positive.

Gelatin stab: No liquefaction.

Agar colonies: Thin, transparent,

Agar colonies: Thin, transparent

Agar slant Growth thin, spreading, veil-like.

Broth. Turbid

Litmus milk Not coagulated, slightly acid.

Potato: No growth.

Nitrates not produced from nitrates.

Starch slightly hydrolyzed.

Thermophilic, optimum temperature

60°C Slight growth at 37°C No growth at 70°C.

Aerobic.

Source: Isolated from guinea pig feces, dust and from cheese.

Habitat: Probably found in soil and decaying matter

Thermobacillus linearius Feirer (Soil Sci., 28, 1927, 53) is said to be similar in some respects to the preceding. Feire states that formation of acid from several sugars is the distinctive feature of this species, a character not mentioned by Berrey.

Source: Five strains isolated from soil.

28a Bacillus stearothermophilus Donk (Jour. Bact, 5, 1020, 373) From Greek stear, tallow and thermophilos, heatloving Intended meaning obscure

From the descriptions, the vegetative rods of this organism seem to be slightly larger than the preceding, otherwise we difference is noted.

Source: Isolated from samples of spoiled canned corn and string beans. Habitat: Probably found in soil and dust.

28b. Bacillus aerothermophilus Weinzirl. (Jour. Med. Research, 49, 1919, 403.) From Greek aeros, air and themophilus, heat-loving. Probably intended to mean aerobic and thermophilus.

There is nothing in the original account of this organism which is at variance with that of the preceding.

Source Isolated from canned string beans (Weinzirl). From milk, water, hay, dust, beef extract, and agar (Prickett, N. Y. Agr. Exp. Station Tech. Bull. 147, 1928, 46).

Habitat: Probably found in soil and

Thermobacillus alcalinus Feirer (Soil Sci., 23, 1927, 52) is said to differ from the preceding in that it does not change litmus milk.

Source · Four strains isolated from soil.

Thermobacillus ruber Feirer (Soil Sci.)

Thermobacillus ruber Feirer (Soil Set., 25, 1927, 52) apparently is closely related to this group. Its distinguishing character is the production of a pink pigment

in meat, brain, and blood serum, no color

Source, Isolated from soil

29. Bacillus thermocellulolyticus Coolhass. (Cent. f. Bakt, II Abt., 76, 1928, 43) From Greek thermos, hot; and Latin cellula, a small room; M. I., cellulose and Greek lytikos, dissolving Probably intended to mean thermophilic and collulose. diversiting

Spores. Ellipsoidal, 0 8 by 1 5 microns, terminal

Sporangia Terminally swollen, clavate Rods: 0 3 by 3 5 to 6 microns, occurring singly and in pairs. No reserve material Non-mottle. Gram-rositive

ion-motile. Gram-positive. Gelatin stab: No liquefaction.

Glucose agar colonies: Small, glistening, translucent

Cellulose agar colonies Circular, borders undulate to lobate.

Broth · Slight growth, no surface growth or sediment.

Milk No growth

Nitrites not produced from nitrates. Starch is hydrolyzed,

No acid from carbohydrates. Cellulose hydrolyzed

Thermophilic, optimum temperature 50°C to 55°C Maximum 60°C to 65°C Minimum 35°C to 37°C

Acrobic, facultative.

Source Isolated from sewage Habitat · Probably found in decaying matter

30 Bacilius thermoalimentophilus Weinzirl (Jour. Med. Research, 39, 1919, 401) From Greek thermos, hot, Latin alimentum, food; and Greek philos, loving Loving hot food

Spores Ellipsoidal, 0.8 by 1.0 micron, terminal.

Sporangia: Swollen, clavate, not in

Rods. 06 by 30 microns, occurring singly, with rounded ends. Motile, flagella not stated. Gram-positive

Gelatin stab . No growth at 20°C.

Agar colonies: Circular, raised, 8m00th, amorphous, entire

Agar slant Growth spreading to effuse,

Broth · Turbid, surface ring.

Litmus milk: Unchanged

Potato: No growth.

Nitrites with gas produced from nitrates

Starch not hydrolyzed.

Neither acid nor gas from glucose, lactose, sucrose or mannitol.

Thermophilic, optimum temperature 55°C. No growth at 20°C. Growth at 37°C.

Aerobic.

Source: Isolated from canned blueberries (Weinzirl). Pasteurized milk and filter cloth (Prickett, N. Y. Agr Exp Sta Tech Bul 147, 1928, 46).

Habitat: Probably found in soil and

Thermobacillus violaceus Feirer (Soil Sci., 23, 1927, 52) corresponds in some respects with the preceding. Feirer also states that his cultures did not reduce nitrates to nitrites and produced acid on cluoses and stigness.

Source · Four strains isolated from soil.

31. Bacillus thermoliquefaciens Bergey et al. (Type 5, var a, Bergey, Jour. Bact., 4, 1919, 304; Bergey et al., Manual, Ist ed., 1923, 313.) From Greek thermos, hot, and Latin liquefaciens, liquefying. Probably intended to mean thermophilic and gelatin-luquefying.

Spores Ellipsoidal, polar, of greater diameter than the rods.

Sporangia Terminally swollen, clavate.
Rods: 0.2 to 0.4 by 2 to 3 microns,

occurring singly, with rounded ends. Motile with peritrichous flagella. Grampositive

Gelatin stab Liquefaction.

Agar colonies: Moderately dense, lobate.

Agar slant: Growth dense, grayish, lobate to fimbriate margins.

Litmus milk: Coagulated, acid. Litmus reduced. Potato: No growth.

Nitrites and ammonia produced from nitrates.

Starch not hydrolyzed.

Thermophilic, optimum temperature 60°C. Slightgrowth at 37°C. No growth at 70°C.

Aerobic.

Source: Isolated from dust, guinea pig feces and horse manure (Bergey). Water and milk (Prickett, N. Y. Agr. Exp. Sta. Tech, Bul. 147, 1928, 47).

Habitat: Probably originally from soil

nd dust.

32. Bacillus tostus Blau. (Cent. f. Bakt., II Abt., 15, 1905, 130.) From Latin tostus, parched, dried.

Spores: Ellipsoidal, 08 to 1.6 by 1.5 to 22 microns. Germination prevail-

ingly polar.

Sporangia: Terminally swollen, clavate, not in chains.

Rods: 12 by 4.5 to 5.0 microns, occurring in pairs and in short chains. Cells store glycogen. Motile with peritrichous flagella

Agar colonies: Small, circular, dense. By transmitted light bright yellow to yellowish-brown. Borders sharp, entire to lobate. Older colonies porcelain-like.

Agar slant: Growth thin, grayish-white, spreading, smooth, glistening.

Potato . No growth.

Nitrites not produced from nitrates. Starch is hydrolyzed.

Ammonia is produced.

Thermophilic, optimum temperature 60°C to 70°C.

Aerobic.

Source Two cultures isolated from soil in Germany.

Habitat: Probably found in soil and dust.

33. Bacillus viridulus (Migula) Bergey et al. (Bacillus thermophilus II Rabinowitsch, Ztschr. f. Hyg., 20, 1895, 154; Bactertum viridulum Migula, Syst. der Bactertum viridulum Migula, Syst. der

ıal,

1st ed., 1923, 315; Bergey et al., Manual, 4th ed., 1934, 464; not Bacillus thermo-philus Miquel, Ann. d. Microg., t, 1838, 6; not Bacillus thermophilus Chester, Man. Determ. Bact., 1901, 265.) From Latin, dim. adj. viridis, green, somewhat green.

Spores: Spherical, central

Sporangia: Cylindrical, not swollen

Rods: Rather large, slightly bent, occurring singly and in pairs. Non-motile. Gram-positive.

Agar colonies: Irregular, spreading, granular, greenish.

Broth: Alkaline.

Potato: Growth grayish-yellow; margin undulate.

Nitrites not produced from nitrates. Starch is hydrolyzed.

Thermophilic, grows at 60°C to 70°C Optimum temperature 62°C. Grows at 33°C.

Aerobic, facultative.

Source: Isolated from soil, snow, feces,

Habitat: Probably found in soil and dust.

Appendix: The following additional aerobic spore-forming bacteria are found in the literature. Because of insufficient data it has not been possible to classify them. Some of these may be synonyms of well-known species, some may be varieties, whereas others may actually be separate species.

Aromabacillus weigmanni Omeliansky. (Isolated by Weigmann, 1890; Omeliansky, Jour. Bact., 8, 1923, 398) From

milk.

Bacillus abysseus ZoBell and Upham.

(Bull. Scripps Inst. of Oceanography,
Univ. Calif., δ, 1944, 273.) Subterminal

Univ. Calif., 6, 1944, 273.) Subterminal spores. From marine mud Bacillus acidifaciens Patrick and

Werkman (Iowa State Coll. Jour. Set, 7, 1933, 413) One of a group characterized by the fermentation of xylan. A single culture isolated from decayed maple wood.

mapre wood.

Bacıllus acidificans presamigenes casei

Gorini. (Rend. R Accad. dei Lincer, 8, 1928, 598) From manure, fodder and milk Regarded by Gorini (personal communication, 1925) as identical with Racullus circulans, Lordan

Bacillus acido-proteolyticus casei Gorini (Le Latt, 9, 1912, 98) From Parmesan and Emmenthal cheese Regarded by Gorini (personal communication, 1923) as equivalent to one of the species of Truebury of Duelaux

Bacillus edemets Trevesan (Brauner Wasserbaeillus, Adametz and Wichmann, Mithell d. oesterr Versuchsstaf f. Braucrei u. Mäizerei, Wien, Heft 1, 1888, 51; Trevisan, I genere le spece delle Batteriacee, 1889, 19; not Bacillus adametsi Migula, Syst. d. Bakt. 2, 1900, 686, Bacillus brunneur Eisenberg, Bakt Ding, 3 Aufl, 1801, 142, Racterum brunneum Migula, thid, 331, not Bacterum brunneum Schroeter, in Cohn, Beitr z Biol d Pfianz. 1, Heft 2, 1882, 125) From water

Bacillus adhaerens Laubach (Jour. Bact, 1, 1916, 503) One culture iso-

lated from dust

Bacillus acyptiacus Werner (Cent f
Bakt, II Abt., 87, 1933, 459) Good
growth on Ca n-butyrate agar. One

Bacillus aerifaciens Steinhaus (Jour Bacillus aerifaciens Steinhaus (Jour Bact, 48, 1941, 782) Author states that it probably belongs to the Aerobacillus

group From triturated specimens of the white cabbage butterfly (Pieris rapae) Bacillus aerobius von Wahl (Cent f. Bakt, II Abt, 16, 1906, 496) Reported to resemble Bacillus mesentercus fuscus

Bacillus aerophilus Flügge. (Flügge, Die Mikroorganismen, 2 Aufl, 1886, 321; Bacterium aerophilum Chester, Man Determ Bact, 1901, 191) From dust.

From canned peas

Bacillus afanassiefi Trevian (Bacillus tussis consulsiros Afanassief, St. Petersburg, med. Wochnychr, 1887, No. 33-42, not Bacillus tussis consulsina Lehmann and Neumann, Bakt Duz, 4 Aufl, 2, 1907, 260; Trevisan, I generi e la specie delle Batteriace, 1889, 13; Baspecie delle Batteriace, 1889, 13; Bacillus pertussis Migula, Syst d. Bakt , 2,

Bacillus agilis Tachistovitsch. (Techistovitsche, Techistovitsche, Perl. klin. Wochnschr., 1892, 512; not Bacillus agilis Trevisan, I genere e le spece delle Batteriacee, 1829, 14; not Bacillus agilis Chester, Man Determ Bact, 1901, 226; not Bacillus agilis Mattes, Sitrungsber, d. Gesellsch. z. Beforderung d gesam Naturw. z. Marburg, 62, 1927, 406; not Bacillus agilis Hauduroy et al, Dict. d. Bact. Path. Paris, 1897, 33). From puss.

Bacillus agilis Hauduroy et al. (Bacillus agilis larios Toumanoff, Bull. Soc. Cent de Méd Vétér., 89, 1927, 307; Hauduroy, Ehringer, Urbain, Guillot and Magrou, Dictionnaire de Bactéries Pathogènes, Paris, 1937, 33 ) Found in foulbrood of bees.

Bacıllus ogresits Werner (Cent. f. Bakt, II Abt., 67, 1933, 463; not Bacıllus ogresits de Rossi, Microbiol. agrarıa etechnica, Torno, 1927, 823.) One of a group of species described as being able to grow on a Can-butyrate agar Three cultures were isolated from German and Italian soils

Bacillus agri Laubach and Rice. (Jour Bact, 1, 1916, 516) Isolated twice from soil in Baltimore

Bactlus agrophilus Stührk. (Cent f. Bakt, II Abt, 95, 1935, 189) Only moderate growth on Ca n-butyrate agar. One culture isolated from soil from Cuba.

Bacillus agrotidis typhoides Pospelov. (Rept Bur Appl. Ent., Russian, 3, 1927, 8) Found in diseased larvae of the moth. Luroa (Agrotis) scaelum.

Bacillus (Streptobacter) albuminis Schroeter (Breillus aus Faces V, Bienstock, Zischr f klin Med, 8, Heft 1, 1884, 1, Schroeter, in Cohn, Kryptog. Flora v Schlessen, 5, 1, 1889, 162; Bacillus putrificus coli Flügge, Die Mikroorgansmen, 2 Aufl, 1886, 303; Bacillus daphthrus Trevisan, I generi e le spece delle Batteracce, 1889, 15.) From feces.

Bacillus albus (Sack) Bergey et al. (Cellulomonas albus Sack, Cent. f. Bakt, II Abt, 62, 1924, 79; Bergey et al., ManBacillus alcalophilus Vedder. (Ned. Tijdschr. v. Hyg. Microbiol. en Scrolog., 1, 1934, 141.) Grows only in and on highly alkaline culture media. Sixteen strains isolated from the feces of healthy animals.

Bacillus alopecuri Nogtev. (Botanicheskii Zhurnal, U.S. S.R., 23, 1938, 149.) Causes nodule formation on fox grass (Alopecurus pratensis).

Bacillus alpha Dyar. (Ann. N. Y. Acad. Sci., 8, 1895, 366.) From the air. Bacillus alpinus Werner. (Cent. f. Bakt., II Abt., 87, 1933, 465.) Good growth on calcium salts of formic, acetic, propionic and butyric acids. One culture isolated from soil from Austria.

Bacillus alreolaris Ksenjoposky. (Review of pests of Volhymia, Volhymia, Ent. Bur., Zemstvo of Volhymia, Zitomir, 1916, 24 pp.) From diseased bees (Apis mellifera).

Bacillus amarus Hammer. (Iowa Agr. Exp. Station Res. Bull. 52, 1919, 198.) From evaporated milk

Bacillus aminovorans den Dooren de Jong. (Cent. f. Bakt., II Abt., 71, 1927, 215.) From soil.

Bacillus amyloaerobius Crimi (Abst. in Cent. f. Bakt., II Abt., 61, 1924, 63.) From potato rot.

Bacillus amylolyticus Kellerman and McBeth (Cent. f. Bakt., II Abt., 34, 1912, 490.) Decomposes cellulose. One culture isolated from manure.

Bacillus annuliformis Migula. (Fadenähnlicher Bacillus, Maschek, Bakt. Untersuch d. Leitmentzer Trinkwässer, Leitmentz, 1887; Migula, Syst d. Bakt, 2, 1900, 783.) From water.

Bacillus anthracis similis McFarland. (Cent. f Bakt, I Abt., 24, 1898, 556) From dust

Bacillus apicum Canestrini. (Atti Soc. Ven. Trent. Sci. Nat., 91; according to Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 233.) From diseased bees and their larvac.

Bacillus aporrhocus Fuller and Norman. (Jour. Bact , 46, 1913, 277.) From soil. Decomposes cellulose.

Bacillus arachnoideus Migula. (Bacillus No. III, Flugge, Zischr. f. Hyg., 17, 1894, 294; Bacillus lactis No. III, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1890, 208; Migula, Syst. d. Bakt., 2, 1900, 583; Bacterium lacteum Migula, 19id., 321.) From milk.

Bacillus arenarius Stuhrk. (Cent t. Bakt., II Abt., 93, 1935, 187.) Good growth on Ca n-butyrate agar. One strain isolated from Cuban soil.

Bacillus aridus Migula. (Bacillus No. 8, Pansini, Arch. f. path. Anat, 122, 1890, 444; Migula, Syst. d. Bakt, 2, 1900, 559) From sputum.

Hacillus arlongii (sic) DeToni and Trevisan. (Bacillus de la septicènie gangrèneuse, Arloing and Chanveau, see Crookshank, Man. of Bact., 3rd ed., 1830, 305; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 950.) From wounds in cangrenous septicaemia

Bacillus asiaticus Sakharofi (Sakharofi, Ann. Inst. Past., 8, 1893, 550; not Bacillus asiaticus Castellani, Cent. f. Bakt., I Abt., Orig., 65, 1912, 262.)

From feces in a case of cholera.

Bacillus asteris Verona. (Riv. Pat
Veg., 25, 1935, 15.) Pathogenic for

China aster (Aster chinensis).

Bacillus asthenagenes Rotnard. (Ann. Inst. Past., 35, 1921, 459.) Grows aerobically as well as anaerobically. Under anaerobic conditions it is said to play a role in gastru derangement and infection commonly confused with beribert. Author reports that it is very similar to Bacillus megatherium.

Bacillus aterrimus tschilensis Klimenko. (Cent. f. Bakt., II Abt., 29, 1908, 1.) Reported to be like the black potato bacillus except that it forms a black pigment on gelatin and the potato is brown instead of black. From air.

Bacillus aurantius (Sack) Bergey et al.

(Cellulomonas aurantius Sack, Cent f. Bakt., II Abt., 62, 1924, 78, Bergey et al., Manual, 3rd ed., 1930, 421; not Bacillus aurantius Trevisan, I generi e le specie delle Batteriacce. 1889, 19.) From soil

Bacillus badrus Batchelor. (Jour. Bact, 4, 1919, 25) From the intestinal tract of children

Bacillus balcanus Bartels. (Cent. f.

Bakt., II Abt., 103, 1940, 25) Growth on media containing M/50 phenol Eight strains isolated from soil.

Bacillus barbitistes Statelov. (Mitt bulg ent Gesells , 7, 1932, 56-61) From diseased tettigonids (Isophya (Barbitistes) amplipennis).

Bacillus batatae Otani (Trans. Tottori Soc. Agric Sci, Japan, 6, 1939, 222) From rotten sweet potatoes (Ipomaea batatas)

Bacillus bellus Heigener (Cent f Bakt, II Abt, 93, 1935, 96) Probably a strain of Bacillus brevis. One culture isolated from garden soil of Germany

Bacillus bernensıs Lehmann and Neumann (Aromabacıllus, Burrı, Cent f Bakt, II Abt, 2, 1897, 699, Lehmann and Neumann, Bakt Diag, 2 Aufl. 2, 1899, 301, Bacillus odoratus Miguls, Syst. d Bakt, 2, 1990, 688, Bacterum odoratum Omelnasky, Jour. Bact, 6, 1923, 391; From Emmenthal cheese Reported as producing the aroma of this cheese

Bacillus beta Dyar (Ann N Y Acad Sci, 8, 1895, 366) From dust

Bacillus belainoiorans Heigener (Cent f Bakt, II Abt., 93, 1935, 94) Good growth on betaine and value agar One culture isolated from soil from Mantus.

Bacillus betanigrificans Cameron, Esty and Williams (Food Research, 1, 1936, 75.) From blackened canned beets where juice contains an abnormally high amount of iron.

Bacillus biacutum Soriano (Revista del Inst Bacteriol., Univ. Buenos Aires, 6, 1935, 564.) From soil.

Bacillus bombyeis Macchiati (Des vibrions, Pasteur, Études sur la maladie des vers à soie, La Flacherie, Chapitre II, Paris, 1870; Macchiati, Starons spermentali Agraric Italiane, 20, 1801, 121; not Bacıllus bombycis Chatton, Compt rend. Acad Sci., Paris, 180, 1913, 1708; Bacıllus megaterum bombycis Savamura, Tokyo Imp. Coll. Agric. Bull., 6, 1905, 373 b Pasteur originally isolated this large bacıllus from the ıntestine of salkworns (Bombyz mori) suffering from witt disease. Regarded by Savamura as a variety of Bacıllus mecaderium.

Bacillus bombycis non-liquefaciens Paillot. (Ann. Épiphyt., 8, 1922, 131, L'infection chez les insectes, 1933, 288.) Larvae of the gypsy moth (Lymantria dispar) are immune to this bacillus

Bacillus bombycoides Paillot. (Compt. rend Acad Agr. France, 28, 1942, 158.) Causes lesions because of a bacterial toxin. From infected silkworms

Bacillus bombysepticus Hartman (Lingnan Sci Jour., 10, 1931, 280) Causes a disease of the silkworm (Bombyz mori)

Bacillus borborokoites ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ Calif., 5, 1944, 274) Central spores From marine bottom deposits

Bacillus borstelensis Stührh. (Cent. f Bakt, II Abt., 93, 1935, 179.) Grows well on Ca n-butyrate agar. Resembles Bacillus rufescens of the same group except that it does not show the typical brown coloration of media. Two strains solated from soils in Germany.

Bacillus bredemanni Chester (Bacillus adhaerens Stührk, Cent f Bakt., II Abt, 33, 1935, 183, not Bacillus adhaerens Laubach, Jour Bact., f, 1916, 503, Chester, in Manual, 5th ed., 1932, 675) Weak growth on Ca n-butyrate agar One strain isolated from Cuban soil.

Bacillus bronchitidus Migula (Bacillus der putriden Bronchitis, Lumnitzer, Cent f Bakt., 5, 1888, 621; Bacillus bronchitidus putridae Lumnitzer, Wien. med Presse, 1888, 606; Migula, Syst. d. Bakt., 2, 1900, 611; Bacterium lumnitzeri Chester, Man Determ. Bact., 1901, 120) From sputum in cases of putrid bron-

Bacillus bruneus Migula. (Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, 1837; Migula, Syst. d. Bakt., 2, 1900, 835; not Bacillus brunneus Eisenberg, Bakt. Diag., 3 Aufl., 1891, 142.) From water.

Bacillus brunneus Eisenberg. (Brauner Wasserbacillus, Adameta and Wichmann, Die Bakt. d. Nutz- u. Trinkwasser, Mitth. Oesterreich. Versuchssta. f. Brauerei u. Malzerei, Wien, Heft 1, 1888, 51; Eisenberg, Bakt. Ding., 3 Aufl., 1891, 142; not Bacillus brunneus Schroeter, in Cohn, Kryptog. Flora v. Schlesien, 3, 1, 1880, 158; Bacterium brunneum Migula, Syst. d. Bakt., 2, 1900, 331.) From water. Non-motile.

Bacillus bullerovii Serbinow. (Věst. Russ. obšě. pčelovod. (Messager de la Soc. russe d'Apiculture), No. 3 and No. 11, 1912; see Rev. Appl. Entomol., Ser. A. 1, 1913, 94 and 441.) From black brood of bees.

Bacillus butschlif Schaudinn. (Arch. f. Protistenkunde, 1, 1902, 5005.) Characterized by its large size (3.0 to 6.0 by 24 0 to 80.0 microns) and granular protoplasm. From the intestine of a cockroach (Blatla (Periplaneta) orientalis).

Bacillus butyricus Hueppe, (Hueppe, Mitteil, kaiserl Gesundheitsamte, 8, 1884, 309, not Bacillus butyricus Macé, Traité de Bact, 18t ed., 1888; not Bacillus butyricus Botkin, Ztschr. f. Hyg., 11, 1892, 421; Clostridium hueppes Trevisan, 1 generi e le specie delle Batteriacee, 1889, 22; Bacillus pseudobutyricus Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 207, Bacillus hueppei Chester, Man. Determ Bact., 1901, 276.)

Bacillus calfactor Miebe. (Arb. der deutsch. Landw. Gesel., Berlin, Heft 3, 1905, 76; Die Selbsterhitzung des Heues, Jena, 1907, 49.) Thought to be the most important thermogenic microorganism in the Iermentation of hay. From heating hay

Bacillus canaliculatus Wilhelmy.

(Arb. bakt. Inst. Karlsruhe, 3, 1903, 20) From meat extract.

Bacillus canceris Migula. (Syst. d. Bakt., 2, 1900, 625.) From a case of stomach cancer.

Bacillus caniperda Migula. (Oralbacillus der Hundestaupe, Galli-Valeno, Cent. f. Bakt., I Abt., 19, 1805, 691; Migula, Syst. d. Bakt., 2, 1900, 761; Bacterium canis Chester, Man. Determ Bact., 1901, 193.) From nasal mucus and urine of dozs.

Bacillus capillaceus Wright. (Mem Nat. Acad. Sci., 7, 1895, 456.) From water.

Bacillus capsici Pavarino and Turconi. (Atti Istit. Bot. R. Univ. Pavia, 15, 1018, 207.) Causes leaf wilt of pepper (Capsicum annuum). May be identical with disease caused by Pseudomona vesicatoria (Stapp, in Soraner, Handbuch der Pflanzen-Krankheiten, 2, 5 Auß, 1998, 2623.)

Bacillus carniphilus Wilhelmy. (Arb bakt. Iust. Karlsruhe, 3, 1903, 19) From meat extract.

Bacillus carnosus Zimmermann. (Tila, Bakt. Untersuch. d. Feelburg. Leitungswässer, Leipzig, 1890, No 57; Zimmermann, Bakt. unserer Trink-u. Nutzwasser, Chemnitz, II Reihe, 1894, 4.) From water.

Bacillus catenulatus Bartels. (Cent. f. Bakt., II Abt., 103, 1940, 27.) Growth on media containing M/100 phenol. Four strains isolated from soil.

Bacillus cepae Bassalik and Edelsztein-Kosowa. (Acta Soc. Bot. Polon, 10, 1933, 519.) From diseased onions (Allium cepa).

Bacillus cerealium Gentner. (Cent.f. Bakt, 11 Abt., 60, 1920, 428; Preudomonas cerealia Stapp, in Soraucr, Handbuch der Pflanzen-Krankholten, 9, 1923, 22; Bacterium ceredinum Elilott, Manual Bacterial Plant Pathogens, 1920, 111.) Pathogenie for barley (Hordeum vulgare), rye (Secale cereale) and wheat (Trilicum Bp.).

Bacillus cinctus Ravenel. (Mem. Nat. Acad. Sci., 8, 1896, 30.) From soil.

Bacillus cirroflagellosus ZoBell and Upham (Bull Scripps Inst. of Oceanography, Univ. Calif., 5, 1944, 266) Central stores. Found in marine mud

Bacillus cladoi Trevssan (Bacille pedunculé, Clado, Bull. Soc Anat. Paris, 1887, 339; Trevisan, I generi e le specie dello Batteriacee, 1889, 14; Bacillus pendunculatus (sie) Eisenberg, Bakt Ding, 3 Aufl, 1891, 340; Bacillus septicus cestica Sternberg, Man. of Bact, 1893, 4475 ) From urine in a case of evatitis.

Bacillus closteroides Gray and Thornton (Cent. I Bakt., II Abt., 73, 1928, 93) Decomposes phonol. Probably identical with or a variety of Bacillus circulans Sixteen strains isolated from Rothamsted soils

Bacillus coccineus Pansini (Pansini, Arch f path Anat , 122, 1890, 437, not Bacillus coccineus Catiano, in Cobn, Beitr z Biol. d Pflanzen, 7, 1896, 339 ) From sputum. Red pigment

Bacillus colorans Libermann. (Jour of Microbiol, Ukraine, 5, 1938, 73, abst in Cent f. Bakt, II Abt, 101, 1940, 81) From fruit conserves containing 10 to 20 per cent sugar.

Bacillus comesis Rossi (Ann d Scuola d Agricult an Portici, 1903, Arch di Farmacologia sperim, 5, 1904, fase 10.) Similar to Bacillus mesentericus. Said to have the ability to dissolve plant particles.

Bacillus concoctans Patrick and Werkman (Iowa State Coll Jour Sci, 7, 1933, 415) Ferments xylan One culture isolated from soil.

Bacillus conjunctivitidis subtiliformis Michalski (Cent. f Bakt, I Abt, Orig, 55, 1904, 212) From more than 50 cases of acute conjunctivitis Similar to Bacillus subtilis

Bactllus consolidus Stührk (Cent. f Bakt, II Abt, 93, 1935, 191) Good growth on Ca n-butyrate agar. One strain isolated from Cuban soil.

Bacillus contextus Migula (Bacillus D. Peters, Botan Zeitung, 47, 1889, Migula, Syst. d Bakt, 2, 1900, 522) From leaven. Bacillus corrugatus Migula. (Bacillus mesentericus vulgatus Flugge, Die Mikroorganismen, 2 Auf., 1886, 322; Bacillus No. II, Flügge, Zischr. f. Hyg, 17, 1894, 294, Bacillus Lactis No. II, Kruse, in Flügge, Die Mikroorganismen, 3 Auf., 2, 1896, 203; Migula, Syst. d. Bakt., 2, 1990, 533.) From milk.

Bacillus corruscans Schroeter. (In Cohn, Kryptog Flora v. Schlesien, 8, 1, 1886, 158) From cooked potato.

Bacillus costatus Lloyd (Jour. Bact, 21, 1931, 94.) From sea water off Scotland. Nitrates and nitrites reduced to nitrogen,

Bacillus crinatus Chester. (Bacillus No. 5, Pansini, Arch f. path. Anat., 122, 1890, 441; Chester, Man. Determ Bact, 1901, 231.) From sputum.

Bacillus crinitus Wright. (Wright, Mem. Nat Acad. Sci., 7, 1895, 453; Bacterium crinatum (sio) Chester, Man. Determ Bact., 1901, 192.) From river water.

Bacillus crystalloides Dyar. (Dyar, Ann N. Y. Aead Sci, 8, 1895, 371; Bacterium crystaloides (sic) Chester, Man. Determ. Bact, 1901, 191.) From the air.

Bacillus cubensis Stührk. (Cent. f. Bakt., II Abt., 93, 1935, 192.) Good growth on Ca n-butyrate agar. Two cultures isolated from soils from Cuba.

Bacillus cystiformis Trevisan (Bacille cystiforme, Clado, Bull. Soc. Anat. Paris, 1887, 339; Trevisan, I generi e lo specie delle Batteriacee, 1889, 14) From utine in a case of cystitis

Bacillus cylaseus McBeth and Scales (U S Dept Agr., Bur. Plant Industry, Bull. 266, 1913, 39; Bacterium cytascum Holland, Jour Bact., δ, 1920, 218.) Requires cellulose for best growth From decomposing materials and soil.

Bacillus cytaveus var. zonalis Kellerman et al (Cent f Bakt., II Abt., 39, 1913, 511) From soil from Utah While no spores were observed, this organism was like Bacillus cytaseus evcept that colonies on cellulose agar showed consentric opaque or semi-opaque and transparent zones.

Bacillus danteci Kruse. (Bacille rouge de Terre-Neuve, Lo Dantec, Ann. Inst. Past., 5, 1891, 662; Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 270.) From reddened salt cod fish.

Bacillus daucarum von Wahl. (Cent. f. Bakt., II Abt., 18, 1906, 494.) Apparently a strain of Bacillus subtilis. From canned carrots.

Bacillus demmei Trevisan. (Bacillus der Erythema nodosum, Demme, Fortschr. d. Med., 6, 1888, 257; Trevisan, I generi e le specie delle Batteriacee, 1889, 14; Bacillus erythematis Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 282; Bacillus erythematis midjoni Kruse, ibid., 449; Bactersum erythematis Migula, Syst. d. Bakt., 2, 1900, 346.) From erythema nodosum (skin).

Bacillus dendroides Holzmüller. (Cent. f Bakt., II Abt., 23, 1909, 331.) From frog feces. Closely related to Bacillus mycoides.

Bacillus dendroides Thornton. (Thornton, Ann. Appl Biol., 9, 1922, 247; not Bacillus dendroides Holzmüller, loc. ett.) Common in Rothamsted soil. Said to belong to the Bacillus subtilis group.

Bacillus dentatus Heigener. (Cent. f. Bakt., II Abt., 23, 1935, 1936) Good growth on valine agar Two cultures isolated from soil of Jugoslavia and North Carolina.

Bacillus destruens von Wahl. (Cent. f. Bakt., II Abt., 16, 1906, 502) From boiled asparagus.

Bacillus detrudens Wright. (Mem. Nat. Acad. Sci., 7, 1895, 452) From water.

Bacillus diastaticus Boyarska (Izvestia Acad Sci., U.S. S.R., Biol Ser., 1941.) Thermophilic.

Bacillus disciformans Zummermann, (Zimmermann, Bakt. unserer Trink. u. Nutzwässer, Chemnutz, II Reihe, 1894, 48; Bacterium disciformans Lehmann and Neumann, Bakt Dag., 1 Auli., 2, 1896, 238) From waste water. Apparently not identical with Bacillus disciformis Grafenhan, although the name suggests possible relationship.

Bacillus disciformis Grāfenhan. (Inaug. Diss., Halle, 1801, 1.) From nater. From the description, this organismmay be Bacillus subtilis.

Bacillus distorius (Duclaux) Trevisan. (Tyrothriz distorius Duclaux, Ann. Inst. Nat. Agron., 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacee, 1889, 16.) From milk.

Bacillus dobelli Duboseq and Grasse (Arch. Zool. Exper. et Gén., és, 1927, 487; Bacillus (Flexulis) dobelli Duboseq and Grassé, tbid., 487.) Similar to Bacillus (fexilis Dobell. Found in rectum of a termite (Caloternes (Glyptolternes) iridipennes). These authors suggest that Bacillus fexilis Dobell, Bacillus batschii Schaudum and Bacillus dobils be grouned under the name Flexilis

Bacillus duclaurii (Miquel) Chester (Bacillus ureae Miquel, Bull. Soc. Chm d Parrs, 31, 1879, 391; Urobacillus duclaurii sive Bacullus ureae ß Miquel, Ann. d. Microg., 2, 1889-1890, 53, 122 and 145; Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 10, 1898, 123.) From water and soil.

Bacillus dysodes Zopf. (Die Spaltpilze, 3 Aufl., 1885, 90.) From fermenting dough.

Bacillus elegans Heigener. (Cent. I. Bakt., II Abt., 93, 1935, 193.) Four cultures isolated from soil, one from Jugoslavia and three from Germany.

Bacillus enulsionis Beijerinck. (Folia Microbiol., 1, 1912, 377; see Perquin, Jour. Microbiol. and Scrol., 6, 1940, 226 ) Produces slime in sucrose solutions

Hacillus encephaloides Trevisan. (Bacille de l'air f, Babes, in Cornil and Babes, Les Bactéries, 1856, 150; Trevisan, I generi e le specie delle Batteriaces, 1889, 20.) From the air.

Bacillus enterothriz Collin. (Arch. Zool. Expér. et Gén., 51, 1913, Notes and Revue, No. 3.) Found in the rectum of toad tadpoles (Alytes sp.).

Bacillus epidermidis (Bizzozero) Bordoni-Uffreduzzi. (Leptothriz epidermidis Bizzozero, Arch. f path Anat, 98, 1884, 441; Bordoni-Uffreduzzi, Fortschr. d Med., 4, 1886, 156; Carcinombacillus. Scheurlen, Deutsche med. Wochnschr. 1887, 1083, Bacillus mesentericus rubiginosus Senger, Cent f. Bakt , 3, 1888, 603; Bacıllus bizzozerianus Trevisan, I generi e le specie delle Batteriacee, 1889, 14, Bacillus scheurlens Dyar, Ann N Y Acad Sci, 8, 1895, 367) From the human mouth and skin Macé (Tearté pratique de Bact, 4th ed, 1901, 1071) says that this organism is the ordinary potato bacillus, i e , Bacillus rulgatus

Bacillus epiphytus ZoBell and Upham (Bull. Scripps Inst. of Oceanography, Univ Calif, 5, 1944, 266) Central spores Found associated with marine

phytoplankton

Bacıllus erodens Ravenel, (Mem Nat Acad Sci , 8, 1896, 35 ) From soil. Bacillus esterificans Maassen a d kareeri Gesundhertsamte, 15, 1890,

504, Plectridium esterificans Huss, Cent f Bakt, II Abt, 19, 1907, 52) Found in a solution of decomposing litmus; also isolated from butter. (Mor-

Bacillus eranidus Grohmann phologisch-biologische Beiträge Kenntnis der Wasserstoffbakterien, In-

aug Disa . Univ Leipzig, 1923 . Cent f Bakt , II Abt., 61, 1924, 207, Rubland and Grohmann, Jahrb Wissensch Botanik, 63, 1924, 321 ) Oxidizes hydrogen in the presence of oxygen to form water Presumably widely distributed in soil Bacillus exiguus Saito (Jour Coll

Sei , Imp Univ , Tokyo, 23, Art 15. 1908, 44 ) Isolated 3 times from garden air

Bacillus exilis Bartels (Cent Bakt , II Abt , 103, 1940, 29 ) Growth in media containing m/100 phenol Eight strains isolated from soil

Bacillus fastidiosus den Dooren de Jong. (Cent. f. Bakt , II Abt., 79, 1929, 314 ) Six strains isolated from unheated garden soil.

Bacillus ferrigenus Bargaglio-Petrucci (Nuovo Giornale botanico italiano, 1913, 1914, 1915; quoted from De Rossi, Microbiol. Agraría e Technica, 1927, 904.) A facultative thermophile, growing up to 65° to 70°C

Bacıllus festinus McBeth. (Soil Sci 1, 1916, 451.) Filter paper decomposed to a grayish-white felt-like mass soil in California,

Bacillus filamentosus Klein see Migula, Syst. d Bakt., 2, 1900, 285; Bacterium filamentosum Burchard, Arb. bakt Inst. Karlsruhe, 2, Heft 1, 1902, 22.) Bacillus filaris Migula (Bacillus No. XI, Flügge, Ztschr. f Hyg, 17, 1894, 296, Bacıllus lactis No. XI, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 209, Migula, Syst. d. Bakt., 2, 1900, 579; Bacillus aromaticus Chester, Man. Determ. Bact., 1901, 276; not Bacillus aromaticus Pammell, Bull. No. 21, Iowa Agr. Exp Sta , 1893, 792; not Bacillus aromaticus Grimm, Cent f. Bakt., II Abt , 8, 1902, 584 ) From milk. Bacillus filicolonicus ZoBell and Up-

(Bull Scripps Inst. of Oceanography, Univ Calif , 5, 1944, 270.) Subterminal spores. From sea water and marine mud

zur

Bacıllus filiformis (Duclaux) Trevisan. (Tyrothrix filiformis Duclaux, Ann. Inst. Nat Agron , 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacee, 1889. 16, not Bacillus filiformis Tils. Ztschr. f. Hyg., 9, 1890, 317, not Bacillus filiformis Migula, Syst d Bakt , 2, 1900, 587.) From cheese Bacillus fissuratus Ravenel, (Mem.

Nat. \cad Sci , 8, 1896, 38 ) From soil. Bacillus fitzianus Zopf (l'itz, Ber. d deutsch chem Gesellsch , 6, 1873, 48; thid , 9, 1876, 1348, thid , 10, 1877, 276, Glycermaethylbacteric, Buchner, in Nagelt, Untersuch ü niedere Pilze, 1882. 220 , Zopf, Die Spaltpilze, 1 Aufl., 1883, 52: Bacterium fitzianum Zopf, Die Spaltpilze, 2 Aufl, 1884, 49) From boiled hav infusions. Forms butyric acid.

Bacillus flagellifer Migula. (Bacillus No VI, Flügge, Ztschr. f. Hyg , 17, 1894, 291; Bacillus lactis No VI, Kruse, in Flugge, Die Mikroorganismen, 3 Aufl , 2, 1896, 209; Migula, Syst. d. Bakt., 2, 1900, 581; Bacillus rudis Chester, Man.
Determ. Bact., 1901, 279.) From milk.
Bacillus flassessas Wise (Wise

Bacillus flavescens Weiss. (Weiss, Arb. bakt. Inst. Karlsrube, 2, Heft 3, 1902, 258; not Bacillus flavescens Pohl, Cent. f. Bakt., 11, 1892, 144.) From brewer's grains. Uncommon.

Bacillus flavidus Stührk. (Cent. f. Bakt., II Abt., 85, 1935, 185, not Bacillus flavidus Fawcett, Rev. Indust. y Agrico. de Tucuman, 18, 1922, 5; not Bacillus flavidus Morse, Jour. Inf. Dis., 11, 1912, 284.) Good growth on Ca. n-butyrate agar. One culture isolated from soil from Egypt.

Bacillus flavidus alrei Klamann. (Bienenwirtschaftl. Cent., Hanover, 1890, No. 2.) Associated with foulbrood of bees.

Bacillus flavoriridis Migula. (Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwässer, Leitmeritz, 1887; Migula, Syst. d. Bakt, 2, 1900, 821.) From water.

Bacillus flexilis Dobell. (Quart. Jour. Microse Sci, 52, 1903, 121; Arch. f Protustenk., 26, 1912, 117.) Reported as being similar to Bacillus bütschlü Schaudinn although only half its size. From the large intestine of frogs (Rana temporaria) and toads (Bufo vulgaris)

Bacillus flexus Batchelor. (Jour. Bact., 4, 1919, 23.) Resembles Bacillus megalherium. From intestinal contents of a child.

Bacillus fluorescens undulatus Ravenel. (Mem. Nat Acad Sci, 8, 1896, 20.) From soil

Bacillus foltaceus Migula (Bacillus mesentericus fuscus Flugge, Die Mikroorganismen, 2 Aufl, 1886, 321; Bacillus No IV, Flugge, Zischr. f Hyg., 17, 1894, 294; Bacillus lacts No. IV, Kruse, 1896, 208, Migula, Syst d. Bakt., 2, 1896, 208, Migula, Syst d. Bakt., 2, 1900, 582) From milk, at and soil.

Bacillus formosus Heigener. (Cent. f. Bakt, JI Abt., 83, 1935, 191, not Bacillus formosus Ravenel, Mem Nat. Acad. Sci., 8, 1896, 12.) One culture isolated from soil from Montenegro. Bacillus foutini Chester. (Bacillus D. Foutin, -Cent. f. Bakt., 7, 1830, 373; Chester, Man. Determ. Bact., 1901, 285.) From hail.

Bacillus frankei (sic) DeToni and Trevisan. (Sarkombacillen, Franck, Münch. med. Wochnschr., 1888, No. 4; abst. in Cent. f. Bakt., 8, 1888, 601, DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 607.) From cases of sarcoma.

Bacillus freudenreichii (Miquel) Clester. (Urobacillus freudenreichii sive Bacillus neue 7 Miquel, Ann. d. Micrographie, 2, 1890, 367 and 488; Chester, Ann. Rept Del. Col. Agr. Exp Sts. 10, 1898, 110.) Lohnis (Cent. f. Bakt., II Abt., 14, 1905, 719) considered this a variety of Bacillus pumilus. Gibson (Jour. Bact., 29, 1935, 493) believed it belonged to the Bacillus pasteurii group although no authentic cultures were available. From soil.

Bacillus frutodestruens Madhok and Ud-Din. (Indian Jour. Agr. Sci., 18, 1943, 129.) Causes a rot of tomato fruit

Bacillus funicularis Kluyver and Yan Niel. (Planta, Arch. f. wissensch. Botanik, 2, 1926, 507.) Exhibits contact irritability. From soil.

Bacillus fursus Goadby (Dental Cosmos, 42, 1900, 322.) From the mouth. Associated with dental caries.

Bacillus (Streptobacter) fusisporus Schroeter. (In Cohn, Krypt. Flora v Schlesien, 3, 1, 1886, 181.) From waste water in a sugar factory.

Bacillus fusus Batchelor. (Jour-Bact., 4, 1919, 27.) Said to resemble Bacillus centrosporus, i e., Bacillus brens. From feces.

Bacillus gangliformis Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 34; Bacterium gangliforme Chester, Man Determ. Bact., 1901, 193.) From soil.

Bacillus gangraenae Chester. (Bacilus gangraenae pulpae Arkövy, Cent. f Bakt., 25, 1897, 921; Chester, Man. Determ. Bact., 1901, 275; not Bacillus gangraenae Tilanus, Nederl. Tijdschr. v. Geneeskunde, 21, 1885, 110) Associated with gangrene of tooth pulp and caries of teeth.

Bacillus gasoformans Pammel. (Pammel, Cent. f Bakt., II Abt., 2, 1896, 642; not Bacillus gasoformans Lisenberg, Bakt. Ding., 3 Aufl., 1891, 107; Bacillus pammelis Chester, Man. Determ Bact, 1001, 270.) From cheest.

Bacillus gelatinosus Migula (Bacterium gelatinosum betae Glaser, Cent f. Bakt, II Abt, f, 1895, 879, Migula, Syst. d Bakt, 2, 1900, 805) Produces slime in sucrose solutions Probably a varsety of Bacillus vulgatus according to Sacchetti (Cent. f. Bakt, II Abt., 95, 1995, 118)

Bacillus geniculatus (Duclauv) Trevisan. (Tyrothriz geniculatus Duclauv, Ann. Inst. Nat. Agron. 4, 1882, 23; Trevisan. I generi e le apecie delle Battoriacee, 1889, 16; not Bacillus geniculatus De Bary, Inaug Diss., Strassburg, Leipzig, 1885; not Bacillus geniculatus Wright, Mem. Nat. Acad. Sci. 7, 1894, 459; Bacillus gonatodes DeToni and Trevisan, in Saccardo, Sylloge Fungotum, 8, 1889, 961; Bacterum geniculatum Migula, Syst. d. Bakt. 2, 1900, 322.) From mills.

Bacillus gigas (Koch) Trevisan.

gigat Koch, in Cohn, Beitr. z Biol. d Planz z, Heth 3, 1877, 429, Metallacter gigat Trevisan, Batter 1tal, 1879, 25; Trevisan, Atti. d. Acad. Fra Med-Stat, Milan, Ser 4, 5, 1886, 96, not Bacillis gigas van der Goot, Med. Troefstation voor de Java Sulkerindust, pt 5, No 10, 1915, 281, not Bacillis gigas Zesisfer and Hassefeld, Arch. f. wiss u prakt Tierheilk, 59, 1929, 419) From perçardial evudate

Bacillus ginglymus Ravenel. (Mem Nat Acad Sci. 8, 1896, 37) From soil. Bacillus glaciformis Wilhelmy. (Arb bakt Inst Karlsrube, 3, 1903, 29) From meat extract. Bacillus globifer Bartels. (Cent f. Bakt, II Abt, 103, 1940, 26.) Growth on media containing 1/100 phenol. Author considers it similar to Bacillus gleet. Five strains isolated from soil

Bacillus glutinis Patrick and Werkman. (Iowa State Coll. Jour. Sci., 7, 1933, 414) Ferments xylan. Two strains isolated from decayed apple wood.

strains isolated from decayed apple wood.

Bacillus glycinophilus Rippel. (Rippel Arch f Mileschie) 8 1077 10

on agar form protein from glycine and glucose.

Bacillus gossypina Stedman. (Alabama Agr Evp Sta Bul. 55, 1894, 6; Earle, Alabama Agr Exp. Sta Bul. 107.

Earle, Alabama Agr Exp. Sta Bul. 107, 1899, 311) Reported as cause of boll rot on cotton (Gossypium sp)

Bacillus granularis Stührk (Cent. 1.

Bakt., II Abt, 93, 1935, 180) Very good growth on Can-butyrate agar. One culture isolated from garden soil in Germany.

Bacillus granulosus Russell (Russell.

Tactitus granulosus Russell (Russell, Zischt f Hyg, 11, 1892, 194, Bacterium granulosum Chester, Man Determ Bact, 1901, 194) From mud from the Gulf of Naples.

Bacillus grossus Migula (Bacterienart No. 13, Lembke, Arch f. Hyg, 20, 1896, 308, Migula, Syst d. Bakt., 2, 1900, 570.) From the intestines of infants.

Bacillus gryllotalpae Metalnikov and

II Abt, 51, 1920, 29) From soil previously fertilized with guano

Bacillus gummosus Happ. (Bakt und Chem Untersuch über die schleimige Gahrung Univ. Basel, 1893, 31, abst in Cent. f Bakt, 14, 1893, 175) From digitalis indivaons. Presumably a mucoid form of a common spore-former Son Bacteria.

Rpt.

1911, 69.) Pathogenic for willow (Saliz sp.).

Bacillus hessii (Guillebeau) Kruse. (Bacterium hessii Guillebeau, Landw. Jahrb. d. Schweiz, 5, 1891, 138; Kruse, in Flugge, Die Mikroorganismen, 3 Aufl. 2, 1896, 210.) There is some question whether the original culture was a spore-former or whether it was mixed with one of the common slimy milk organisms From slimy milk.

Bacillus hirudinis Schweizer. (Arch. f. Mikrobiol., 7, 1936, 235) From the digestive slime of leeches (Hirudo medicinalis and Hirudo officinalis).

Bacillus hollandicus Stapp. (Cent. f. Bakt., II Abt., 51, 1920, 47.) From soil from Delft.

Bacillus hoplosternus Paillot. (Compt. rend. Acad. Sci., Paris, 163, 1916, 774; Ann. Inst. Past., 33, 1919, 403.) Isolated once from the body fluid of a June bug. Pathogenic for several species of insects.

Bacullus imminutus McBeth. (Soil Sci., 1, 1916, 455.) Growth only in the presence of cellulose. From ten different soils of California.

Bacillus immobilis Steinhaus. (Jour. Bact., 42, 1941, 783.) The author states that it probably belongs to the Bacillus adhaerens group. From rectum of larvae of the sphinx moth (Ceratomia catalpae).

Bacillus imomarinus ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif, 5, 1944, 265.) Subterminal spores. From marine bottom denosits in shoal waters

Bacillus indifferens Soriano. (Thesis, Univ. Buenos Aircs, 1935, 565.) One strain isolated from soil

Bacillus infantilis Kendall (Jour Biol. Chem, δ, 1909, 419 and 439) From the intestine in cases of infantilism. Saprophytic.

Bacillus intermittens Wilhelmy (Arb. bakt. Inst. Karlsruhe, 3, 1903, 23) From meat extract

Bacillus intrapallans Forbes (Bull. Illinois State Lab Natur Hist, Art IV, 1886, 283, 288 and 297) Bacillus jubatus Bartels. (Cent. I. Bakt., II Abt., 163, 1940, 24.) Vergood growth on media containing w/80 phenol. Nine strains isolated from soil. Bacillus kaleidoscopicus Withelm, (Arb. bakt. Inst. Karlsruhe, 3, 1903, 31.) From meat extract.

Bacillus kefir Kuntze. (Cent. f Bakt., II Abt., 24, 1909, 116.) From kefir, a Caucasian milk beverage

Bacillus kermesinus Migula. (Karminroter Bacillus, Tatsroff, Inaug Diss, Dorpat, 1891, 67; Migula, Syst. d. Bakt, 2, 1900, 858.) From water.

Bacillus kildini Issatchenko. (Recherches sur les Microbes de l'Océsa Glacial Arctique. Petrograd, 1911) From sea water.

Bacillus koubassaffii Chester. (Bacllus der krebsartigen Neubildungen, Koubassoff, Vortrag Moskauer Miltarärztischen Verein, 1883, No. 22; abt in Cent. f. Bakt., 7, 1890, 317; Chester, Man. Determ. Bact., 1991, 282) From

the stomachs and intestines of birds.

Bacillus lactis albus Chester. (Bacilus lactis albus Sternberg, Man of Bact, 1893, 680; Chester, Man. Determ. Bact, 1901, 277.) From milk.

Bacillus lactucae Voglino. (Ann. R. Accad. Agr. Torino, 46, 1903, 25.) Pathogenic for lettuce (Lactuca satita).

Bacillus lasiocampa Brown. (Amer. Museum Novitates, No. 251, 1927, 7) Said to belong to Bacillus subtilis group From ovaries and egg tubes of tent caterpillar moth

Bacillus latrianus Kalnins. (Latvips Univ. Raksti, Serya I, No. 11, 1930, 205) Cellulose attacked at 34°C but not st 37°C. Probably from soil.

Bacillus tautus Batchelor. (Jour. Bact., 4, 1919, 30) One culture from feces.

Bacillus legrosii Hauduroy et al. (Legros, Thèse Méd Paris, 1902; Hauduroy et al , Dict d Bact. Path , 1937, 43)

Facultative anaerobe producing gaseous gangrone From a gaseous suppuration

Racillus leaumininerdus von Oven (Cent. f. Bakt . II Abt., 16, 1906, 67; Bacterium leguminiperdum Stevens The Fungi which Cause Plant Disease, 1913, 28 ) Pathogenic for lupine (Lupinus sn ) kidney bean (Phaseolus nulgaris) pen (Pisum satirum), tomato (Laconersicum esculentum)

Bacillus lehmanni Herter. (Microbe 5A. Choukévitch, Ann. Inst Past . 25. 1911, 350, Herter, Just's Botan, Jahresber . 39. 2 Abt., Hcft 4, 1915, 748 ) From the large intestine of the horse

Bacillus lekitosis Perlman, (N Y State Dept Agr. and Markets. Ann Rept. 1931, 115.) Egg lecithin hydrolyzed completely by non-erful extracellular enzyme From contaminated sample of whole mixed eggs

Bacillus lesagei Trevisan (Bacille de la diarrhée verte des enfants. Lesage, Bull Acad, Med Paris, Oct 25, 1887. Trevisan, I generi e le specie delle Batterracee, 1889, 14.) From the intestine

of infants. Racillus Ievaniformans Grew Smith.

(Proc. Linn Soc. New South Wales, 26. 1901, 589, 674 and 684; Cent f. Bakt., II Abt . 8, 1902, 506 ) Produces slime in sucrose solutions. Probably a variety of Bacillus vulgatus according to Sacchetti (Cent f. Bakt . II Abt . 95, 1936, 115)

Bacillus licheniformis (Weigmann) Chester, (Bacteria a. Weigmann, Cent. f Bakt., II Abt . 2, 1896, 155; Clostridium Ischeniforme Weigmann, loc cit., 4, 1898. 822, Chester, Man. Determ Bact., 1901, 287; see also Gibson, See Agrie Bact. (British), Abstr Proc. 1927, Paper No. 10. Gibson and Topping, thid , 1938, 43; Gibson, thid , 1943, 13 ) Gibson places this with Bacillus subtiles although it was originally described as being Gramnegative and forming clostridial sporangia. Spore germination polar

Bacillus lichenoides Grohmann. [Morphologisch-biologische Beiträge Kenntnis der Wasserstoffbakterien, Inaug Diss , Univ. Leipzig, 1923, Cent f Bakt., II Abt . 61, 1924, 267; Ruhland and Grahmann Jahrh wissensch Ratanik 63 1024 321.) Oxidizes hydrogen in the presence of overen to form water Presumably widely distributed in soil

Racillus Lansuagans Patrick and Work. (Iona State Coll. Jour. Sci., 7. 1933, 410) Ferments xvlan One culture isolated from decayed maple wood

Bacillus Lianorum Patrick and Werkman. (Iowa State Coll. Jour. Sci., 7. 1933, 410 ) Ferments xylan One culture isolated from decayed apple wood.

Bacillus limnophilus Stuhrk. (Cent. f Bakt., II Abt., 93, 1935, 190 ) Good growth on Ca n-butyrate agar. One culture isolated from soil of Germany.

Bacillus lingardi Trevisan. (Bacillus de la stomatite ulcereuse du veau. Lingard and Batt; Trevisan, I generi e le specie delle Batteriacce, 1889, 14 ) From ulcerations on the tongue and mucous membrane of the mouth of calves

Bacillus lividus Zimmermann. (Bakt. unserer Trink- p. Nutzwässer, Chemnitz II Reshe, 1894, 18; not Bacillus lividus Vores, Cent. f. Bakt., 14, 1893, 203.) From water.

Bacillus Iongior Saito, (Jour. Coll Set., Imp. Univ , Tokyo, 23, Art. 15, 1908. 57.) Isolated once from garden air.

Bacillus longus Migula. (Bacillus No VII, Flugge, Ztschr f Hyg., 17, 1891. 296. Bacillus lactis No. VII. Kruse, in Flüere, Die Mikroorganismen, 3 Aufl. 2. 1896, 209; Migula, Syst. d. Bakt. 2, 1900, 581; not Bacillus longus Chester. Man. Determ Bact . 1901. 303; Bacillus plicatus Chester, ibid , 275, not Bacillus plicatus Frankland and Frankland, Philos Trans, Royal Soc London, 178, B. 1887, 273; not Bacillus plicatus Zimmermann, Bakt unserer Trink- u. Nutzwisser, Chemnitz, I Reihe, 1890, 54; not Bacillus plicatus Dectjen, Inaug. Diss , Würzburg, 1890; not Bacillus plicatus Copeland, Rept. Filtration Commission, Pittsburgh, 1899, 348.) From milk.

tions only a weak reduction. From garden soil.

Bacillus nobilis Adametz. (See Freudenreich, Cent. f. Bakt., II Abt., 7, 1901, 857; ibid., 8, 1902, 673.) This organism was sold under the name Tyrogen; it was said to play a part in the ripening of hard cheese. This was doubted by Freudenreich who identified it as one of the Tyrothriz group Original description apparently in Osterreichen Mokerei-Zeitung, Nov. 15, 1900; Dec. I and 15, 1900; Milehecitung, Nov. 48, 1900.

Bacillus novus (Huss) Bergey et al. (Plectridium novum Huss, Cent. f. Bakt., II Abt., 19, 1907, 256; Bergey et al., Manual, 1st ed., 1923, 301.) From sterilized milk.

Bacillus oblongus Eckstein. (Ztschr. f. Forst- u. Jagdwesen, 26, 1894, 16.) From the larvae of a moth (Hyponomeula evonymella).

Bacillus ochensis Bartels. (Cent. f. Bakt, II Abt., 103, 1940, 28.) Growthon media containing M/100 phenol. One culture isolated from soil.

Bacillus oleae Schiff-Giorgini. (Cent. Bakt , II Abt., 15, 1905, 203.) Thought

to be the cause of tubercles on the clive tree from which it was isolated.

Bacillus omelianslii Serbinoff. (Zhurnal Bolezni Rastenii, Leningrad, 9, 1915, 105.) Causes a rot of sorghum.

Bacillus outerion (Chorine) Steinhaus (Bacierium ontarion Chorine, Internat. Corn Borer Invest., Sci Rpts., 2, 1929, 44, also Ann. Inst. Past., 43, 1929, 1655, B. outerion Paillot, B. presumably indicates Bacterium, see index, p. 522, L'infection chez les insectes, 1933, 134; Steinhaus, Bacteria Associated Extra-recllularly with Insects, Minneapolis, 1942, 72) From diseased larvae of the corn borer (Pyraustra nubilalis Hb.).

Bacillus oogenes Migula. (Bacillus oogenes hydrosulfureus a, Zörkendorfer, Arch (1 ftgs. 16, 1833, 385; Migula, Syst. d. Bakt., 2, 1900, 573.) From hens' eggs. Bacillus opacus Woiss (Arb bakt. Inst. Kalisruhe, 2, Heft 3, 1902, 244.) From bean infusions and fermenting cabbage.

Bacillus orae Werner. (Cent. f. Bakt, II Abt., 87, 1933, 464.) Weak growth on agar containing calcium salts of formic, acetic, and butyric acids. One culture isolated from European soil.

Bacillus oxylacticus Dyar. (Dyar, Ann. N. Y. Acad Sci., & 1895, 369; Bacterium oxylacticus Chester, Ann. Rept Del. Col. Agr. Exp. Sta., 9, 1897, 107.) From air and a culture from Krâl's Iaboratory Iaboled Bacillus oxylacticus The latter is given in the Krâl 1900 catalogue as Bacillus oxalaticus Zopf and undoubtedly was the organism received by Migula from Zopf and studied by him (Alfgula, Arb. tech. Hochschule Karlsruhe, f., Heft 1, 1894, 139 and Migula, Syst. d. Bakt., 2, 1900, 533) This is now regarded as having been Bacillus megatherium De Barv.

Bacillus pabuli Schieblich. (Cent. ! Bakt., II Abt., 58, 1923, 204.) Commonly isolated from green and fermenting fadder.

Bacillus pollidus Heigener. (Cent. I. Bakt., II Abt., 93, 1935, 98.) One strain isolated from soil from New York State.

Bacillus palustris Sickles and Shan-(Jour. Bact., 28, 1934, 418; Rhodobacillus palustris Sickles and Shaw, Jour. Bact., 38, 1939, 241.) Decomposes the specific carbobydrate of pneumococcus type III

From swamp and other uncultivated soils

Bacillus palustris var. gelaticus Sickles
and Shaw (loc. cit., 419). A variety that
decomposes agar slightly. Found only

once.

Bacillus paucicutis Burchard. (Arb. bakt. Inst. Karlsruhe, 2, Heft 1, 1902,

From rye bread.
 Bacillus pectocutis Burchard. (Arbbakt. Inst. Karlsruhe, 2, Heft 1, 1902.

24.) From the air.

Bacillus pelagicus Russell. (Bot
Gaz., 18, 1893, 383.) From sca water and
marine mud from Woods Hole, Massa.

chusetts.

Bacillus pellucidus Soriano. (Revista

del Instit. Bacteriol., Buenos Aires,  $\theta$ , 1935, 567.) Author says colonies resemble Bacillus simplex Habitat probably

ın soıl

Bacillus peptogenes (Buchanan and Hammer) Bergey et al (Bacterium peptogenes Buchanan and Hammer, Iowa Agr. Evp Sta Res. Bull 22, 1915, 273; Bergey et al., Manual, 1st ed., 1923, 273; From a tube of litmus milk after autoclaving.

Bacillus peptonans Chester (Bacıllus lactis peptonans Sterling, Cent. f. Bakt, II Abt. 1, 1895, 473; (Chester, Man. Determ Bact., 1901, 271) From milk Very similar to Bacıllus mesentercus suloatus Fluere.

Bacillus peptonificans Lubenau. (Cent f. Bakt., I Abt., Orig., 40, 1906, 435) Similar to Bacillus subtitis Believed to be the cause of an epidemic of

gastroenteritis

Bacillus perlucidulus Saito (Jour.
Coll Sci., Imp Univ., Tokyo, 23, Art.
15, 1908, 43.) Isolated 3 times from

garden air

Bacillus petiolatus Saito (Jour. Coll
Sci., Imp Univ., Tokyo, 23, Art. 15, 1908,
8.) Isolated twice from garden air

Bacillus phaseolt von Wahl (Cent f Bakt, II Abt, 16, 1906, 500) From canned bears

Bacillus phenolphilos Bartels (Cent. f Bakt, 11 Abt, 103, 1940, 21) Good growth on media containing 11/50 phenol. One culture isolated from goil

Bacillus picrogenes Patrick and Werknian (Iowa State Coll. Jour. Sci., 7, 1933, 410) Ferments xylan One culture isolated from decayed watermelon.

Bacillus piliformis Tyzzer (Jour Med Research, 57, 1917, 397.) All attempts to cultivate the organism failed

Japanese waltzing mice.

Bacillus piscicidus Migula. (Bacillus piscicidus agilis Siebert, Gazeta lekarska, 1895, No. 13-17; abst. in Cent. f. Bakt., 17, 1835, 888, Bacterium piscicidus agilis Chester, Ann. Rept. Del. Col. Agr. Exp. Sts. 9, 1897, 149; Migula, Syst. d Bakt., 2, 1900, 652, Bacillus piscicidus nobilis (sic) Babes and Riegler, Cent. f. Bakt., II Abt., Orig., 38, 1902-03, 440.) Cause of a fish epidemic in St. Petersburg

Bacillus pist von Wahl. (Cent. f. Bakt., II Abt., 16, 1906, 502.) From young peas.

Bacillus platychoma Gray and Thornton. (Cent f. Bakt, II Abt., 73, 1928, 93) Phenol is attacked Three strains isolated from soil.

Bacillus plexiformis Goadby (Denta Cosmos, 42, 1900, 322) From the mouth

Cosmos, 42, 1900, 222) From the mouth Bacallus plicatus Deetjen. (Deetjen, Inaug. Diss., Würzburg, 1800, not Bacıllus pltentus Prankland and Frankland, Philos Trans. Royal Soc. London, 178, B., 1887, 273; not Bacıllus plteatus Zimmermann, Bakt. unscree Trank- u. Nutz-wisser, Chemnitz, I Reihe, 1800, 54; not Bacıllus plteatus Copeland, Rept. Filtration Commission, Pittsburgh, 1809, 348; not Bacıllus plteatus Chester, Man Determ. Bact., 1991, 275.) From sausage

Bacillus pollacii Pavarino. (Atti R Accad Naz Lincei Rend Cl. Sci. Fis. Math e Nat.; 20, 1911, 233) Reported to cause depressed spots on leaves of Odonloolossum citrosmum.

Bacillus populi Brisi. (Atti Cong Nat Ital. Pom. della Soc. Ital. di Sci. Nat. Milano, 1907, 376) Reported as cause of galls on branches of poplar trees (Populus sp.)

(10 pains 39)

Bacillus pseudanthracis Kruse (Milzbrandthnlicher Bacillus, Burri, Hyg.

Rundschau, 4, 1891, 339, 489t. in Cent. f.

Bakt, 18, 1894, 374; Kruse, in Flügge,

Die Miknorganismen, 3 Aufl. 2, 1896,

233; not Bacillus pseudanthracis Wahr
lich, Bakteriol Studen, Petersburg,

1890-91, 26; Bacillus pseudo-anthracis

Chester, Man. Determ. Bact., 1901, 280.)

From South American bran.

Bacillus pseudococcus Migula (Bacil-

lus No. 11, Pansini, Arch. f. path. Anat., 122, 1890, 446; Migula, Syst. d. Bakt., 2, 1900, 557.) From sputum.

Bacillus pseudodiphthericum magnus Odeganrd. (Acta Path. et Microbiol. Scand., 21, 1944, 451; see Endicott, Biol. Abst., 20, 1946, 12926.) From the mose of a child suspected of having diphtheria. Resembles Corynebacterium diphtheria in young cultures. Non-pathogenic.

Bacillus pscudofusiformis Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 23, Art. 15, 1908, 47) Isolated once from garden air.

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Bacillus pseudosubtilis Migula. (Bacillus subtilis similis Sternberg, Manual of Bact., 1893, 679; Migula, Syst. d. Bakt., 2, 1900, 618.) From the liver of a yellow fever cadaver.

Bacillus punctiformis Chester. (Bacillus No. 23, Conn, Storrs Agr. Exp. Sta. Rept., 1893, 53; Chester, Man. Determ. Bact., 1901, 284.) From milk.

Bacillus pyenoticus Grohmann. (Cent. f. Bakt., II Abt., 61, 1924, 261; Ilulland and Grohmann, Jahrb. wissenseh. Botanik, 63, 1924, 281; Hydrogenomonas pyenotica Bergey et al., Manual, 3rd ed., 1930, 34.) Oxidizes hydrogen in the presence of oxygen to form water. Presumably widely distributed in soil.

Bacillus quercifolius Destjen. (Deetjen, Inaug. Diss., Wurzburg, 1890; Bacterium quercifolium Migula, Syst. d. Bakt. 2, 1900, 309.) From sausage

Bacillus rarercpertus Schieblich. (Cent. f. Bakt, I Abt, Orig., 124, 1932,

269.) From beet leaves.

Bacillus rarus Werner. (Cent. f. Bakt, II Abt., 87, 1933, 456) Good growth on Ca n-butyrate agar One culture isolated from forest soil of Germany

Bactllus repens Gibson. (Cent. f. Bakt., II Abt , 92, 1935, 370.) Decomposes urea Eight strains isolated from soil.

Bacillus reptans Ghosh. (Compt. rend. Soc. Biol , Paris, 86, 1922, 914.) From a case of appendicitis.

Bacillus retaneus Grohmann. (Morphologisch- biologische Beiträge zu Kenntnis der Wasserstoffakterien, Laaug. Diss., Univ. Leipzig, 1923; Cent. I. Bakt., II Abt., 61, 1924; 267; Ruhland and Grohmann, Jahrb wissensch. Dolani, 62, 1924, 321.) Oxidizes hydrogen in the presence of oxygen to form water. Pre sumably widely distributed in soil.

Bacillus retiformis Migula (Netzbacillus, Maschek, Bakt. Untersuch. d. Leitmeritzer Trinkwasser, Leitmentz, 1887; Migula, Syst. d. Bakt., 2, 1900, 712)

From water.

Bacillus robustus Weiss (Weiss, Atb bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 247; not Bacillus robustus Blau, Cent f Bakt., II Abt., 16, 1905, 134.) From fermenting beets.

Bacillus ruber Zimmermann. (Zimmermann, Die Bakt. unserer Trink-Nutzwässer, Chemnitz, 1, 1890, 21; not Bacillus ruber Cohn, Beitr. z. Biol d Pflanz., 1, Heft 3, 1875, 181; Bacellut pseudoruber Migula, Syst d. Bakt, ?, 1900, 850; Erythrobacillus ruber Holland, Jour. Bact . 5, 1920, 223, line 15; Serratia rubra Bergey et al., Manual, 1st ed. 1923, 92; Chromobacterium ruber Toples and Wilson, Princip. of Bact. and Immun., 1, 1931, 402.) From Chemaits spores. See tan water. Spherical Manual, 5th ed., 1939, 607 for a description of this species

Bacillus rufescens Stuhrk. (Cent. I Bakt., II Abt., 93, 1935, 178.) Charaterized by good growth on Can-butyrate agar. One culture isolated from garden soil of Germany.

Bacillus rufulus Saito. (Jour. Coll Sci., Imp. Univ., Tokyo, 23, Art. 15, 1908, 59 ) Isolated 3 times from garden air.

Bacillus rugosus Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, I. Heft I. 1891, 28; not Bacillus rugosus Wright, Mem. Nat. Acad. Sci., 7, 1805, 435; not Bacillus rugosus Chestor, Man. Determ Bact., 1901, 220.) From Swiss cheese

Bacillus rugulosus Stührk. (Cent. f Bakt., II Abt., 93, 1935, 181.) One of s group of species described as growing well on Ca n-butyrate agar Three strains isolated from soils of Germany, Cuba and Italy

Bacillus sacchari Janse. (Mededeel. uit's Lands. Plantentuin, 9, 1891, 1) Reported to cause screh, a disease affecting sugar cane (Saccharum officinarum) Went (Arch. voor de Java Suikerindustrie, 1895, 589) regards this as probably Bacillus vibilië.

Bacillus saccharolyticus Nepomnjatschipja and Libermann (Jour f Mikrobiol., Ukraine, 5, 1938, 57; abst. Cent f Bakt, II Abt, 101, 1940, 81) From plum preserves A gas-producing rod.

Bacillus saccobranch: Dobell (Quart Jour Micro. Sci., 56, 1911, 441) From heart blood of a fish (Saccobranchus fossilis)

Bacillus santiagensis Stuhrk. (Cent f Bakt., II Abt., 93, 1935, 188) Good growth on Ca n-butyrate agar One culture isolated from Cuban soil

Bacillus saprogenes Migula. (Bacillus saprogenes iri III, Kramer, Bakterologie in ihren Beziehungen zur Landwirtschaft, 2, 1892, 137; Migula, Syst d. Bakt, 2, 1900, 572; not Bacillus saprogenes I, II and III, Herfieldt, Cent f. Bakt, II Abt., I, 1895, 77, not Bacillus saprogenes Salus, Artch f. Hyg., 51, 1994, 115) From wine.

Bacillus saprogenes Chester (Bacilus saprogenes vini VI, Kramer, Balteriol Landwritsch, 2, 1892, 189; Chester, Man Determ Bact., 1901, 289, not Bacillus saprogenes Trevisan, I genere e le specie delle Batteriacce, 1889, 17) From wine

Bacillus scaber (Duclaux) Trevisan (Tyrothrix scaber Duclaux, Ann Inst. Nat Agron, 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacce, 1889, 16) From milk.

Bacillus schollelii Trevisan. (Darinhacillus, Lydtin and Schottelius, Der Rotlauf der Schweine, Weisbaden, 1885, 214, Bacillus coprogents fuetidus Flügge, Die Mikroorganismen, 2 Aufl., 1886, 305, Trevisan, I generi e le specie delle Batteriacce, 1889, 17; Baclerium coprogenes Migula, Syst. d Bakt., 2, 1900, 327; Baclerium scholtelii Chester, Man. Determ. Bact., 1901, 197.) From the intestinal contents of syme.

Bacillus segetalis Werner. (Cent. f Bakt, II Abt, 87, 1933, 467) Characterized by growth on Can-butyrate agar. One strain isolated from soil in Germany. Bacillus sentica-acrabius Haudunny et

al. (Bacille septique aérobie, Legros, Thèse Méd, Paris, 1902; Hauduroy et al., Diet. d Bact Path, 1937, 46) Aerobic, facultative. From a case of acute gaseous gangrene.

Bacillus septicus insectorum Krassilstschik (Memoires de la Soc. Zool de France, 6, 1893, 250.) From cockchafer larvae (Melolontha melolontha).

Bactilus serrulatus Stührk. (Cent f. Bakt, II Abt., 93, 1935, 193.) Only moderate growth on Ca n-butyrate agar. One culture isolated from Cuban soil.

Bactilus sesam: Malkoff (Cent. f. Bakt, II Abt., 16, 1906, 665) Pathogenic on scsame (Sesamum).

Bacillus siccus Chester. (Bacillus No. 25, Conn, Storrs Agr Exp. Sta Rept, 1893, 63; Chester, Man Determ. Bact, 1901, 284) From milk.

Bacillus similus Schroeter. (Bacillus II, Bienstock, Zischr d klin. Med., 8, 1884, Heft I and 2; Schroeter, in Cohn, Kryptog-Flora v. Schlesien, 8, 1, 1880, 160, Bacillus coprocinus Trevisan, 1 generi ele specie delle Batteriace, Milan, 1880, 16, Bacellus facealis No II, Kruse, in Flüge, Die Mikroorganismen, 3 Auf., 2, 1896, 215. Bacterium simile Chester, Man Determ Bact., 1901, 197.) From feces

Bacillus similis Eckstein (Arch f. Forst- u Jagduesen, 26, 1891, 11.) From infested larvae of the nun moth (Lymantria monacha), etc.

Bacillus similityphosus Migula. (Typhusähnlicher Bacillus, Maschek, Bakt. Untersuch d Leitmeritz. Trinkwässer, Leitmeritz, 1887; Migula, Syst. d. Bakt., 2,1900,730) From water Bacillus sinapiragus Kossowicz. (Cent. f. Bakt., II Abt., 23, 1909, 241.) From pickles.

Bacillus sombrosus Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 429.)

From the stomach of a bird.

Bacillus sorghi Burrill. (The Microscope, 7, 1837, 321; Proc. Amer. Soc. Microscopists, 1888, 193; Bacterium sorghi Chester, Delaware Agr. Exp. Sta. Ann. Rept., 9, 1897, 127; Elliott and Smith, Jour. Agr. Res., 58, 1928, 1.) Reported to cause a disease of sorghum (Holeus sorghum)

Bacillus sotto Paillot. (Sotto-Bacillus, Ischivata, quoted from Aoki and Chisanski, Mitteil. d. Med Fakul. d. k. Univ. z. Tokyo, 13, 1915, 419 and 14, 1915, 59; Bacterium sotto Metalnikov and Chorine, Internat Corn Borer Invest., Sci Repts., 1, 1928, 56, Paillot, ibid., 1, 1928, 77-196.) From silkworms (Bombyz mori). Sotto is Japanese for "plotzlich hinfallen".

Bacillus spatiosus Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 25, Art. 15, 1908, 56.) Isolated once from garden air.

Bacillus spermatosoides Eckstein. (Zitschr. f. Forst- u. Jagdwesen, 26, 1894, 13.) From dead moths (Hyponomeuta evonymella).

Bacillus sphaerosporus Beijerinck. (Cent. I. Bakt., II Abt., 25, 1909, 45.) This organism has round terminal spores and produces nitrous oxide from nitrates From garden soil.

Bacillus sphaerosporus calco-aceticus Beijerinek (loc cit., 46). A variety of the above having spherical to ellipsoidal

spores.

Bacillus spinosporus Soriano. (Thesis, Univ. Buenos Aires, 1935, 562.)
Spores spinate like some strains of Bacillus polymyra. No gas formed.
One strain isolated from soil.

Bacillus spiralis Migula. (Syst. d. Bakt., 2, 1900, 624.) From water.

Bacillus spirogyra Dobell (Quart Jour. Micro. Sci , 53, 1909, 579 and 56, 1911, 434) From large intestine of frog (Rana temporaria) and toad (Bufo vulgaris). Bacillus spongiosus Aderhold and Rubland. (Cent. f. Bakt., 11 Abt., 15, 1905, 376.) Found in the gum masses discharged by cherry trees.

Bacillus sporonema Schnudinn. (Arch f. Protistenkunde, 2, 1903, 421.) From

sea water.

Bocillus spurius Grohmann. (Morphologisch-biologische Beiträge zur Kenntnis der Wasserstoffbakterien, Inaug. Dies., Univ. Leipzig, 1923; Cent. Fakt., 11 Abt., 61, 1924; 267; Rubland Grohmann, Jahrb. wissenach Botanik, 63, 1924, 321.) Oxidizes phydien in the presence of oxygen to form water. Presumably widely distributed in soil.

Bacillus sputi Chester. (Bacillus No 6, Pansini, Arch. f. path. Anat., 122, 1890, 442; Chester, Man. Determ. Bact., 1901, 280) From sputum.

Bacillus squamiformis Saito. (Jour. Coll Sci., Imp. Univ., Tokyo, 23, Art 15, 1908, 54.) Isolated 9 times from garden soil.

Bacillus stellaris Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 23, Art. 15, 1928, 52.) Isolated 6 times from garden air.

Bacillus stellatus Zimmermann. (Zummermann, Bakt. unserer Trink- u. Netrusser, II Reihe, 1894, 14; not Bacillus stellatus Chester, Man. Determ. Bact., 1901, 274; not Bacillus stellatus Vincent. Ann. Inst. Past., 21, 1907, 62.) Frangater.

Bacillus streptoformis Migula. (Salpeter zerstbrenden Bacillus, Schirokith. Cent. f. Bakt., II Abt., § 1896, 20; Migula, Syst. d. Bakt., § 1900, 62; Bacillus schirokikli Chester, Man. Determ. Bact., 1901, 252; Bacillus denitificans Chester, ibid., 274.) From hors feces Utilizes potassium nitrate.

Racillus suaveolens Sclavo and Gosio. (Quoted from Omeliansky, Jour. Bact., 8, 1923, 398.) No source given.

Racillus subcuticularis Miguls. (Bactilus cuticularis albus Tatarofi, Indug. Diess., Dorust, 1891, 24; Miguls, Syst. d. Bakt., 2, 1900, 623; Bacillus cuticularis Chester, Man. Determ. Bact, 1901, 285.) From water.

Bacillus sublanatus Wright, (Mem. Nat Acad. Sci., 7, 1895, 455 ) From -

Racellus sublustrie Schieblich (Cont. f Bakt., II Abt., 58, 1923, 206.) Commonly isolated from green and fermenting foddere

Racillus submarinus ZoRell and Un-(Bull. Scripps Inst of Oceanography. Univ Calif . 5, 1944, 267 ) Central ovate spores. From marine bottom Bacillus (Streptobacter) subtiliformis

deposits.

(Bacillus I. Bienstock. Schroeter. Ztschr f klin Med , 8, Heft 1 and 2. 1884 Schroeter, in Cohn. Kryptog -Flora v. Schlessen, 3, 1, 1886, 160, Bacillus mesenthericus (sic) Trevisan, I generi e le specie delle Batteriacce, Milan, 1889, 15 not Racillus mesentericus Trevisan. thid 19: Bacillus subtilis simulans I. Eisenberg, Bakt Diag . 3 Aufl . 1891. 189. Bacillus faecalis No. I. Kruse, in Flügge, Die Mikroorganismen, 3 Aufl 2. 1898. 215. Bacterium sybtile Migula. Syst d Bakt , 2, 1900, 292, Bacterium subtiliforme Chester, Man Determ Ract . 1901, 197 ) From feces.

Racillus succinicus Fitz (Quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 966 ) From

infusions.

Bacillus suffuscus Grohmann. (Morphologisch-biologische Restrage Kenntnis der Wasserstoffhakterien, Inaug Diss., Univ. Leipzig, 1923, Cent f Bakt , II Abt , 61, 1924, 267, Ruhland and Grohmann, Jahrb wissensch. Botanik, 63, 1921, 321 ) Oxidizes hydrogen in the presence of oxygen to form water Presumably widely distributed in soil.

Bacillus supraresislans Stührk. (Cent. f. Bakt., II Abt., 93, 1935, 185.) Very good growth on Ca n-butyrate agar One culture isolated from soil in Germany.

Bacillus surgeri Dornic and Daire. (Bull, mensuel de l'Office de renseignements agricoles, 6, 1907; abst. in Rev. Gén. du Lait., 6, 1907, 161.) Spores not observed but author stated that they were probably present because this

enecies could withstand 85°C for 5 minutes From whev.

Racellus tabaer III Koning (Trideche voor toegenaste scheikunde en hygiene. Deel 1, 1897. See Behrens, Mykologie der Tabakfabrikation, in Lafar, Handbuch der techn Mykologie, 5, 1905, 11.) Thermophilic. Probably from soil

Bacillus tardieus Stuhrk. (Cent. f. Bakt . II Abt . 93, 1935, 177.) Very slight growth on Ca n-butyrate agar. One culture isolated from garden soil of Germany

Racillus technicus Morikawa and Proscott. (Jour Bact . 13, 1927, 58; also see Morikawa, Bull Agr Chem. Soc. Japan. 5. 1927, 28) Produces butyl and isopropyl alcohols Source not given.

Bacillus tenar Eckstein (Ztschr f. Forst- u Jagdwesen, 26, 1894, 14 ) From larvae of the nun moth (Lymantria monacha).

Bacillus tenuis non-liquefaciens Choukévitch (Ann Inst Past . 25, 1911, 352) From large intestine of horse

Bacillus terminalis Migula. (Bacillus No XII, Flugge, Ztschr. f. Hyg. 17. 1894, 296; Bacillus lactis No. XII, Kruse. in Flügge. Die Mikroorganismen, 3 Aufl., 2, 1896, 209, Migula, Syst d. Bakt., 2, 1900. 578; Bacillus lacteus Chester. Man. Determ. Bact., 1901, 291.) From milk. A duplicate of Bacterium semperninum Migula

Bacillus terminalis var thermophilus Prickett. (N. Y. Agr. Exp Sta. Tech. Bull. 147, 1928, 44.) Produces a brown water soluble pigment on agar; optimum temperature 55°C to 65°C. Fourteen strains from raw and pasteurized milk. milk powder, and skin of a cow.

Bacillus terrestris Werner. (Cent. f. Bakt , II Abt., 87, 1933, 461.) Weak growth on Ca n-butyrate agar, Two strains isolated from soils of Germany.

Bacillus tetanoides Saito. (Jour. Coll. Sci , Imp Univ., Tokyo, 23, Art. 15.

1908, 49 ) Isolated once from garden air. Bacillus thalassokoites ZoBell and Upham. (Bull. Scripps Inst. of Oceanography, Univ. Calif., 5, 1911, 268.) Central spores. From marine bottom deposits. Bacillus theae Hori and Bokura. (Jour. Plant Protection, Tokyo, 2, 1015, 1.) Pathogenic for tea (Thea sinensis).

Bacillus thermoabundans Beaver. Dissertation, Ohio State University, Columbus, 1932, 31.) Thermophilic, subterminal spores. Growth at 55°C, less growth at 37°C. From malted milk powder.

Bacillus thermoacetigenitus Beaver, loc. cit., 25. Thermophilic, central spores. No growth at 37°C. From vinegar.

Bacillus thermoacidificans Renco. (Ann. Microbiol., 2, 1942, 600) From Grana cheese whey. This is stated by Gorini (R. Ist. Lombardo Sci. c. Lett., Rend., 76, 7° della Ser. 3, 1942, 3) to be the same as Bacillus lactis termophilus Gorini.

Bacillus thermoactivus Beaver, loc. cit., 27. Thermophilic, central spores. No growth at 37°C. From home-canned beets.

Bacillus thermognnulatus Beaver, loc. cit., 17. Thermophilic, subterminal spores. No growth at 37°C. From commercially canned tomatoes

Bacillus thermoaquatilis Beaver, loc. cit, 18. Thermophilic, subterminal spores. No growth at 37°C. From a warm spring at Springfield, Ohio.

Bacillus thermoarborescens Beaver, loc. cit., 30. Thermophilic, sub-terminal to central spores. Growth at 55°C, less growth at 37°C From candy.

Bacillus thermobutyrosus Beaver, loc. cit., 15. Thermophilic, subterminal spores. No growth at 37°C. From commercially canned tomatoes.

Bacillus thermocompactus Beaver, loc. 1ct., 20. Thermophilic, subterminal spores. No growth at 37°C. From red grapes stored in sawdust.

Bacillus thermodactylogenitus Beaver, loc. cit., 28. Thermophilic, central to subterminal spores Growth at 37°C and 55°C. From commercially packed dates.

Bacillus thermoeffervescens Beaver, loc.

cit., 23. Thermophilic, central spaces No growth at 37°C. From commercially canned peas.

Bacillus thermofaccalis Beaver, loc cit., 30. Thermophilic, subterminal spores. Growth at 55°C. From leces of robin.

Bacillus thermofibrincolus Itano and Arakawa. (Ber. d. Ohara Inst. f. landwirsch. Forschungen, Japan, 4, 1929, 265) Thermophilic; decomposes cellulose. From soil containing decomposed leaves.

Bacillus thermofiliformis Beaver, loc. cit., 22. Thermophilie, subtermind spores. No growth at 37°C. From commercially canned peas.

Bacillus thermograni Beaver, loc. ct., 16. Thermophilic, subterminal spores No growth at 37°C. From commercially canned corn.

Bacillus thermolongus Beaver, loc. cii, 19. Thermophilic, subterminal spores No growth at 37°C. From commercially canned tomatoes.

Bacillus thermolubricans Beaver, lac. cit., 26. Thermophilic, central spores No growth at 37°C. From lubricating oil.

Bacillus thermononodorus Beaver, loc. eit., 26. Thermophilic, central spores No growth at 37°C. From tap water.

Bacillus thermonubilosus Beaver, loc. cit, 19. Thermophilic, subterminal spores. No growth at 37°C. From soil, Yellow Springs, Ohio.

Bacillus thermoodoratus Beaver, loc. cit., 29 Thermophilic, central spores Growth at 55°, less growth at 37°C From spoiled gelatin.

Bacillus thermopellitus Beaver, laccit., 22. Thermophilic, central spores. No growth at 37°C. From old cour milk. Bacillus thermophilus Miquel (Miquel, Ann. d. Microgr., 1, 1888, 4, Bacillus thermophilus miquelit Kruse, in Flugge, Die Mikroorganismen, 3 Auß., 2, 1896, 269; Bacterium termophilum (sic) Migula, Syst. d. Bakt., 2, 1900, 342; Bacterium miquelit Chester, Man.Determ. Bact., 1901, 186.) From the

intestine, water and soil. Thermophilic. No growth below 40°C

Bacillus thermophilus sojae Rokusho and Fukutome. (Jour. Agr. Chem Soc., Japan, 13, 1937, 1235) From spontaneously heating soy-bean cake.

Bacillus thermosuavis Beaver, loc cit., 24 Thermophilic, central spores No growth at 37°C. From commercially canned mincement.

Bacillus thermotenax Beaver, loc ctt., 28 Thermophilic, subterminal spores. Growth at 37°C and 55°C From ground horseradish.

Bacillus thermourinalis Beaver, loc. cit, 16. Thermophilie, subterminal spores. No growth at 37°C. From human urine.

Bacillus thermoviscidus Beaver, loc. cit, 21 Thermophilic, subterminal spores. No growth at 37°C. From fresh De ovary

Bacillus thoracis Howard (Gleanings in Bee Culture, 28, 1900, 124) From black brood of the honey bee (Apis mellifera).

Bacillus tracheitis sive graphilosis Krassistschik (Memoires de la Soc Zool de France, 6, 1893, 250) Fron discased larvae of the coekchafer (Melolontha melolontha).

Bacillus tricomi: Trevisan (Bacillo della gangraena senilia; Tricom, Italia Tricom, Italia tricomi el metria di Med e Chir, 5, 1886, 73, Trevisan, I generi e le specie delle Batteriace, 1889, 13; Bacterium tricomi: Migula, Syst. d Bakt, 2, 1900, 310) From a caso of senile gangrene

Bacillus trifolis Voglino. (Ann R. Accad Agr. Torino, 59, 1896, 85) Pathogenic for clover (Trifolium pratense, T.

repens, T. resupinatum).

Bacillus tritus Batchelor. (Jour-Bact, 4, 1919, 29.) One culture from forces.

Bacillus tuberis von Wahl (Cent. f. Bakt., II Abt., 16, 1906, 503) From cooked truffles (Tuber oestirum)

Bacillus tuberosus Weiss. (Arb. bakt

Inst Karlsruhe, 2, Heft 3, 1902, 248) From fermenting beets

Bacillus tubifex Dale. (Annals of Bot., 26, 1912, 133.) Reported to cause a leaf disease of potato (Solanum tuberosum) and tomato (Lycopersicum esculentum).

Bacillus turgidus (Duclaux) Trevisan. (Tyrothriz turgidus Duclaux, Ann. Inst. Nat. Agron, 4, 1882, 23; Trevisan, I generi e le specie delle Batteriacee, 1889, 16) From milk.

Bacillus tympani-cuniculi Morcos. (Jour. Bact, 23, 1932, 454.) Causes tympanitis in young rabbits

Bacillus ubicuitarius Soriano. (Estudio sistematico de algunas bacterias esporuladas aerobias, Thesis, Univ. Buenos Aires, 1935, 569) Four cultures isolated from soil.

Bacıllus ulna Cohn. (Cohn, Beitr. z. Biol d. Pflanz., 1, Heft 2, 1872, 177; also see Prazmowski, Untersuch. ti. d. Ent-wickelungsges. u Fermentwirk. einiger Bakterienarten, Leipzig, 1880, 20.) Found once in an infusion of cooked egg-white

Bacillus undulatus den Dooren de Jong (Bull Assoc. Diplômés de Microbiol. Nancy, No. 26-27, 1946, 12) From soil.

Bacillus uvaeformis Kern. (Arb bakt. Inst Karlsruhe, 1, Heft 4, 1896, 415.) From the stomachs and intestines of birds.

Bacillus vaculatus Ravenel. (Mem. Nat Acad Sci., 8, 1896, 31.) From soil. Bacillus talidus Heigener. (Cent. f. Bakt., II Abt., 95, 1935, 97.) Four cultures isolated from soil from Germany, Cuba, and Egypt.

Bacillus ralinotorans Heigener. (Cent. f Bakt., II Abt., 93, 1935, 104)

Bacillus varians Saito. (Jour. Coll. Sci., Imp. Univ., Tokyo, 25, Art. 15, 1908, 50) Isolated 11 times from garden air.

Bacillus tentricosus Heigener. (Cent.

f. Bakt., II Abt., 93, 1935, 102; not Bacillus ventricosus Weiss, Arb. bakt. Inst. Karlsruhe, 2, 1898, 233.) One culture isolated from soil from Italy.

Bacillus ventriculus Koch, (Botan. Zeitung, 46, 1888, 341.) From slices of carrot exposed to the air. Formed two spores in a spindle-shaped sporangium.

Bacillus vernícosus Zimmermann. (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, II Reihe, 1894, 46; not Bacillus vernicosus Migula, Syst. d. Bakt., 2. 1900, 781.) From waste water.

Bacillus verticillatus Ravenel. (Ravenel, Mem. Nat. Acad. Sci., 8, 1896, 13; Bacterium verticillatum Chester, Man. Determ. Bact., 1901, 192.) From soil.

Bacillus vesicae Migula. (Bacillus septicus vesicae Clado, quoted from Eisenberg, Bakt. Diag., 3 Aufl., 1891, 341; Migula, Syst. d. Bakt., 2, 1900, 620.) From urine in a case of cystitis. Probably is Bacillus clador Trevisan.

Bacillus villosus Zimmermann. (Bakt. unserer Trink- u. Nutzwässer, Chemnitz, II Reihe, 1894, 38; not Bacillus villosus Keck, Inaug. Diss., Dorpat, 1890, 47.) From water.

Bacıllus violaceus Eisenberg. (Bakt. Diag., 2 Aufl , 1888, 8; not Bacellus violaceus Schroeter, Kryptogamen-Flora von Schlesien, 3, 1886, 157; not Bacıllus violaceus Frankland and Frankland, Ztschr. f Hyg., 6, 1888, 394.) Said to produce central spores. From water. Sack.

viridi-glaucescens Bacillus (Cent. f. Bakt., II Abt., 65, 1925, 113) From several kinds of soil.

Bacillus viridiluteus Pagliani et al. (Grungelber, nicht verflussiger Bacillus, Eisenberg, Bakt. Diag, 1 Aufl., 1886, Tab. 6; Pagliani, Maggiora and Fratini, Soc. ital d'igiene, 1887, 586, see Trevisan, I generi e le specie delle Batteriacee, 1889, 19). From water

Bacillus viscosus bruxellensis van Laer. (Cent. f. Bakt., II Abt., £5, 1909, 159.) From beer wort.

(Bacıllus Bacillus eiticola Burgwitz vitis Merjanian and Kovaleva, Prog. Agric. et Vitie., 95, 1930, 594 and 98, 1931. 17; not Bacillus vitis Montemartini, Rev. Patol. Veg., 6, 1913, 175; Burgwitz, Phytopath. Bacteria, Leningrad, 1935, 37.) Pathogenic for the grape vine.

Bacillus vitreus Migula (No. 11, Lembke, Arch. f. Hyg., 26, 1896, 306; Migula, Syst. d. Bakt , 2, 1900, 569 ) From the intestines of infants.

Bacillus vogelii Migula. (Roter Kartoffelbacillus, Vogel, Ztschr. f. Hyg , 28, 1897, 404; Migula, Syst. d. Bakt., 2, 1900, 556; Bacillus viscosus Chester, Man. Determ. Bact., 1901, 286; not Bacillus viscosus Frankland and Frankland. Ztschr. f. Hyg., 6, 1889, 391.) From stringy bread.

Bacillus watzmannii Werner. (Cent. f. Bakt., II Abt., 87, 1933, 462.) Weak growth on Ca n-butyrate agar. One culture isolated from soil of Germany.

Bacillus weigmanni Migula. (Bakterie II. Weigmann and Zirn, Cent f. Bakt., 15, 1894, 465; Migula, Syst. d Bakt., 2, 1900, 693.) From soapy milk.

Bacillus xylanicus Patrick and Werkman, (Iowa State Coll. Jour. Sci. 7, 1933, 415.) Ferments xylan. One culture isolated from decayed apple wood.

Bacillus xylophagus Patrick and Werkman. (Iowa State Coll. Jour. Sci., 7, 1933, 414.) Ferments xylan. One culture isolated from decayed apple wood

Bacillus zirnii Migula. (Bakterie III, Weigmann and Zirn, Cent. f. Bakt., 15, 1894, 466; Migula, Syst. d. Bakt , 2, 1900,

693.) From soapy milk.

Bacterium adametzii Migula. (Bacillus No. XIV, Adametz, Landwirtsch. Jahrb., 18, 1889, 246; Migula, Syst. d Bakt., 2, 1900, 338; Bacterium rugosum Chester, Man. Determ. Bact., 1901, 194.) From cheese.

Bacterium aloes Passalacqua. (Rev. Pat. Veg., 19, 1929, 110.) From diseased aloes

Bacterium angulans Burchard. (Inaug. Diss., 1897; Arb. bakt. Inst. Karlsruhe, 2, Heft 1, 1902, 43 ) From water.

Bactersum aqueum Migula. (Bacillus Rabinowitsch, VIII, thermophilus Ztschr. f. Hyg., 20, 1895, 160; Miguls.

Syst. d. Bakt., 2, 1900, 345; Bacterium thermophilum VIII, Chester, Man. Determ. Bact., 1901, 186.) From feces

and corn

Bacterium articulatum Kern. (Arb. bakt Inst. Karlsruhe, 1, Heft 4, 1897, 445.) From the stomach and intestines of birds.

Bacterium asparagı von Wahl (Von Wahl, Cent f. Bakt, 1I Abt., 16, 1906, 498; Bacillus asparagi Lehmann and Neumann, Bakt. Diag, 4 Aufl, 2, 1907, 436) Irom boiled asparagus

Bacterium brachysporum Burchard. (Inaug Diss., 1897; Arb. bakt. Inst. Karlsruhe, 2, Heft 1, 1902, 20) From

bakery bread.

Bacterium canadensis Chorine ternat. Corn Borer Invest., Sci Rpts., 2, 1929, 39; also Ann. Inst. Past., 45, 1929, 1658; Bac. canadensis Chorine and Metalnikov. Ann Inst Past, 43, 1929, 1392; also Paillot, L'infection chez les insectes, 1933, 134 where Bac, equals Bacterium, see index p 522; Bacillus canadensis Steinbaus, Bacteria Associated Extracellularly with Insects, Minneapolis, 1912, 50) In its general characters said to resemble Bacillus megatherium and other bacteria isolated from insects (Bacillus thuringiensis, Bacillus hoplosternus, etc ). Pathogenic for larvae of Purausta nubilalis, Galleria mellonella, and Ephestia kuhniella From diseased larvae of the corn borer

Bacterium cattleyas Pavarino (Atti R Accad. Naz Lincei Rend Cl. Sci. Fis., Mat. c. Nat., 20, 1911, 233.) From

diseased orchids.

Bacterium casaubon Metlalnikov. (Compt. rend. Soc. Biol., Pars. 105, 1930, 536; tao varieties, Bacterium casaubon I and II, are recognized by Metlalnikov, Ermolaev and Schobaltryn, Internat Corn Borer Invest., Sci. Repts., 5, 1930, 30 and Ann. Inst. Past., 46, 1931, 469) From diseased corn borer larvae (Pyrausta nubilatis Ib).

Bacterium christies Chorine. (Internat. Corn Borer Invest., Sci. Rpts , 2, 1929, 46; also Ann. Inst. Past., 43, 1929, 1666.) According to the author, this closely resembles Bacterium ontarioni. Several strains isolated from diseased corn borers.

Bacterium colomatri Chester. (Colomatii, Breslauer arztliche Ztschr., 1883, No. 4; Chester, Man. Determ. Bact., 1901, 186) From xerotic masses in conjunctivitis.

unctivitis.

Bacterium deliense Swellengrebel. (Archiv f Protist, 51, 1913, 277.) Observed in stained smears from the spleen of diseased cattle but not isolated Two spores may form in a single cell if division is delayed.

Bacterium ephesilae No. 1 and No. 29 Metalnikov and Chorine. (Ann Ins.) Past, 43, 1929, 1991.) Not pathogenij for corn borer although the size of thi larvae was reduced. Later, Ellingry and Chorine (Internat. Corn Borer Investigations, Sci. Rpts. 5, 1930, 37) identified these as strains of Barllus': thurnguensis. From diseased larvae of Ephestia kuehnriella.

Bacterium filjorme Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 41, not Bacterium filjorme Migula, Syst. d. Bakt, 2, 1900, 296; Bacterium subfiljorme Migula, 1bid., 297) From Saiss cheese.

Bacterium galleriae No. 1, Chorine. (Bâtonnet mince, Metalnikov, Compt., rend. Acad. Sci., Paris, 175, 1922, 69; Chorine, Ann. Inst. Past., 41, 1927, 1115.) From diseased larvae of the bee moth (Galleria mellonella).

Bacterium gelleriae Chorine. (Plus grand bâtonnet, Metalnikov, Compt. rend Acad. Sci. Paris, 173, 1922, 70; Chorine, Compt. rend. Soc. Biol., Paris, 85, 1926, 200, Bacterium gelleriae No. 2, Chorine, Ann Past. Inst. 41, 1927, 1117.) From diseased larvae of the bee moth (Galleria mellonella). Resembles Bacillus megatherum. Pathogenie for the corn borer (Internat. Corn Borer Invest, Sc. Repts. 1, 1927, 46).

Bacterium galleriae No. 3, Chorine (Ann. Inst. Past., 41, 1927, 1118) From diseased larvae of the bee moth (Galleriae mellonella). Resembles Bacullus subtilis and Bacillus mesentericus. Bacterium giganteum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 453.) From the stomach and intestines of birds.

Bacterium glaucescens Migula. (Bacilius thermophilus VI, Rabinowitsch, Zischr. f. Hyg., 20, 1895, 185; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum VI, Chester, Man. Determ. Bact., 1901, 185.) From feces.

Bacterium glutinosum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 441) From the stomach of a dove.

Bacterium ilidzense Migula. (Bacıllus ildzensis capsulatus Karlinski, Hygenische Rundschau, 5, 1895, 688; Digula, Syst. d. Bakt., 2, 1900, 340.) rom the water of a hot spring. Therapphilic.

Barterium implectans Burchard. (Inaug. Diss., 1897; Arb. bakt. Inst. Karlsruhe) 2, Heft 1, 1898, 29.) From drinking water.

Bacterium insulosum Wilhelmy. (Arb. bakt. Inst. Karlsruhe, 3, 1903, 16)
From meat extract.

Bacterium insulum Weiss. (Arb. bakt. Inst. Karlsruhe, 2, Heft 3, 1902, 252.) From fermenting malt.

Bacterium inlactum Migula. (Bacillus thermophilus V, Rabinowitsch, Ztschr. f. Hyg., 20, 1895, 183; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum V, Chester, Man. Determ. Bact., 1901, 185) From feces and corn.

Bacterium irss Migula. (Irisierender Bacillus, Tataroff, Inaug. Diss., Dorpat, 1891, 57; Migula, Syst. d. Bakt., 2, 1900, 313; not Bacterium rris Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 125.) From water.

Bacterium italicum No. 1 and No. 2, Metalnikov, Ermolaev and Skobaltzyn (Ann. Inst. Past., 46, 1931, 470; No. 2 is also described in Internat. Corn Borer Invest. Sci Repts., 5, 1930, 30.) From larvae of the corn borer (Pyrausta nubilalis).

Bacterium longum Kern. (Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1894, 391; Bacterium squamosum longum Kern, 1bid., 458; Bacillus squamosus longus Chorine, Ann. Inst. Past, 41, 1927, 1114.) From the intestines of a dove (Columba oenas). Bacterium lunula Dobell. (Quart

Bacterium lunda Dobell. (Quart Jour. Micro. Sci., 63, 1909, 579.) From rectum of the toad (Bufo rulgaris). Resembles Bacterium binucleatum Swellengrebel

Bacterium lydiae Migula. (Bacillus thermophilus I, Rabinowitsch, Zischr. f. Hyg., 20, 1895, 156; Migula, Syst. d. Bakt., 2, 1900, 343; Bacterium thermophilum I, Chester, Man. Determ. Bact., 1901, 185.) Widely distributed in soil, anow, feees, corn.

Bacterium mansfieldii Chester. (Bacillus No. 18, Conn, Storrs Agr. Expt Sta., 1893, 51; Chester, Man. Determ. Bact., 1901, 197.) From milk.

Bacterium markusfeldii Chester. (Bacillus der trichorrhexis nodosa, Markusfeld, Cent. f. Bakt. f. Abt., et., 1897, 230; Chester, Man. Determ. Bact., 1901, 192.) Associated with the disease, trichorrhexis nodosa.

Bacterium mesentericum Migula. (Bacitius mesentericus panis viscosi I, Vogel, Ztschr. f. Hyg., 29, 1897, 401; Migula, Syst. d. Bakt., 2, 1900, 314; Bacterium panis Chester, Man. Determ. Bact., 1901, 1961.) From stringy bread dough.

Bacterium mesenteroides Migula. (Bacillus No. XVII, Adametz, Landor, Jahrb., 18, 1839, 249; Migula, Syst. d. Bakt., 2, 1900, 312; Bacterium viscosum Chester, Man. Determ. Bact., 1901, 194) From cheese.

Bacterium modestum Bersteyn. (Arb bakt. Inst. Karlsruhe, 5, 1903, 95) From soil.

Bacterium monstrosum Henrici. (Arb bakt. Inst. Karlsruhe, 1, Heft 1, 1891, 47.) From Swiss cheese.

Bacterium nephritidis Migula. (Bacillus nephritidis interstitidits Letterich, Ztsehr. f. klin. Med., 15, 188-, 33; Migula Syst. d. Bakt., 2, 1900, 310; not Bacterium nephritidis Chester, Man Determ. Bact., 1901, 145.) From urine in cases of nephritis.

Bacterium ochraceum Migula. (Ba cillus viscosus ochraceus Freund, Martin Inaug. Diss., Erlangen, 1893, 37; Migula, Syst. d. Bakt, 2, 1900, 333.) From the prolessity.

Bacterium olivae Montemartini. (Atti Inst Bot Pavia Univ., 2 ser, 14, 1914, 154) From diseased olive branches.

Bacterium paludosum McBeth. (Soil Sci, 1, 1916, 463) Filter paper reduced to a white pulp-mass. From two soils in California.

Bacterium persitomaticum Burchard (Arb. bakt. Inst. Karlsruhe, 2, 1898, 11.) Similar to or identical with Bacillus ruminatus (Gottheil, Cent. f. Bakt., II Abt., 7, 1901, 485). From soil.

Bacterium pituitans Burchard (Inaug. Diss., 1897; Arb. bakt Inst. Karlsruhe, 2, Heft 1, 1898, 8.) From a brown concretion in a cooked egg.

Bacterium plicativum Weiss (Weiss, Arb bakt Inst. Karlsruhe, 2, Heft 3, 1902, 223; not Bacterium plicativum Migula, Syst. d. Bakt., 2, 1900, v and

453) From fermenting beets and malt Bacterium plicatum Henrici. (Henrici, Arb. bakt. Inst. Karlsruhe, 1, Heft 1, 1894, 49; not Bacterium plicatum Chester, Man Determ Bact., 1901, 166) From

brick cheese.

Hansen.

Bacterium pseudoceti Migula (Bacillus No. XV, Adametz, Landw Jahrt, 18, 1889, 247; Migula, Syst. d. Bakt., 2, 1900, 320, Bacterium turgidum Chester, Man. Determ Bact., 1901, 195.) From cheese Characteristic involution forms very similar to those of Bacillus accii

Bacterium pseudomycoides Migula. (Migula, Syst d. Ilakt, 2, 1900, 486; Bacillus pseudomycoides roseus Nepveux, Thèse, Fac. Pharm, Nancy, 1920, 112) From soil

Bacterium pseudovermiculosum Saito. (Jour Coll Sci., Imp. Univ, Tokyo, 25, Art 15, 1908, 62) Isolated twice from garden air.

Bacterium pyrenes No. 1, No. 2 and No. 3, Metaloikov, Ermolaev and Skobaltzyn. (Internat. Corn Borer Invest., 5, 1930, 28 and Ann Inst. Past., 46, 1931, 467, 463 and 460 respectively, presumably the

same as Bacillus pirenei Pospelov, Lenin Acad. Agr. Sci. (USS.R.), Ann. Rept. 1936, 318-321.) No. 1 from discased larvae of the corn borer (Pyrausta nubilalis) that had become black after death; No. 2 from larvae that had become brwn; and No. 3 from larvae that had become pinkish-brwn.

Bacterium radiatum Kern (Kern, Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 438; Bacterium barbatum Migula, Syst. d Bakt., 2, 1900, 317.) From the stomach of a finch.

Bacterium rusticum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 440) From the stomach of a sparrow.

Bacterium sempervivum Migula. (No NII, Flügge, Zischr. f. Hyg., 17, 1894, 296; Bactilus lactus No. XII, Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 299; Migula, Syst. d. Bakt., 2, 1900, 321.) From milk

Bacterium serratum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 451.) From the intestine of a dove.

Bacterium sewerin: Migula. (Sewerin, Cent. f. Bakt., II Abt , 5, 1897, 709; Migula, Syst. d. Bakt , 2, 1900, 330) From manure.

Bactersum spissum Kern. (Arb. bakt. Inst Karlsruhe, 1, Heft 4, 1896, 446.) From the intestine of a bird.

Baclersum sputcola Migula. (Bacillus No 4, Pansini, Arch. I. path. Anat., 122, 1800, 440; Migula, Syst. d. Bakt. 2, 1900, 306; Baclerium sputs Chester, Man. Determ. Bact., 1901, 190) From sputum.

Baclerum streplococcyjorme Migula.
(Bacillus thermophilus 111, Rabinowitsch, Zischr. f. Hyg., 20, 1895, 186; Migula, Syst. d. Bakt., 2, 1900, 313; Baclerum thermophilum 111, Chester, Man. Determ. Bact., 1901, 185) From soil, feces, corn.

Bacterium subdenticulatum Migula. (Bacillus thermophilus VII, Rabinowitsch, Ztschr. f. Hyg, 20, 1805, 158; Bacterium subrubeum Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 450; Bacillus subrubeus Nepveux, Thèse, Fac. Pharm., Nancy, 1920, 115.) From the intestines of birds.

Bacterium subsquamosum Migula. (Bacterium squamosum longum Kern, Arb. bakt. Inst. Karlestue, J. Hoft 4, 1896, 458; Migula, Syst. d. Bakt., 2, 1890, 333.) From the intestines of a dove.

Bacterium subthermophilum Migula. (Bacillus thermophilus IV, Rabinowitsch, Ztschr. f. Ilyg., 20, 1805, 157; Migula, Syst. d. Bakt., 2, 1900, 344; Bacterium thermophilum IV, Chester, Man. Doterm. Bact., 1901, 186.) From soil and foccs.

Bacterium subtilis var. galleriae Chorine. (Ann. Inst. Past., 41, 1927, 1120.) From diseased larvae of the bee moth (Galleria mellonella).

Bacterium tenax Kern. (Arb. bakt. Inst. Karlsruhe, 1, Heft 4, 1896, 443.) From the stomachs of birds.

Bacterium terrae (Ucke) Chester. (Streptobacillus terrae Ucke, Cent. f. Bakt., I Abt., 23, 1893, 1031; Chester, Man. Determ Bact, 1901, 199.) From 801.

Bacterium truncatum Chester. (Bacillus No. 51, Conn, Storrs Agr. Exp. Sta., 1894, 81; Chester, Man. Determ. Bact., 1901, 195, not Bacterium truncatum Migula, Syst. d. Bakt., 2, 1900, 407; not Bacterium truncatum Chester, ibid., 157.) From milk.

Bacterium verrucosum Kern. (Arb. bakt. Inst. Karlsruhe, I, Heft 4, 1896, 434.) From the stomachs and intestines of birds.

Bacterium virgula (Duclaux) Migula. 'Tyrothrix virgula Duclaux, Ann. Inst. Mat. Agron , 4, 1882, 23; Migula, Syst. d. Bakt., 2, 1900, 323.) From cheese.

Bacterium viride van Tieghem. (Van Tieghem, Bull. Soe Bot France, 1880, 174; Bacillus viridis Trevisan, I generi e le specie delle Butteriacee, 1889, 18) Celtulobacillus mucosus Simola. (Ann. Ac. Sc. Fenn., Ser. A, 34, 1931; abst. in Cent. f. Bakt., II Abt., 83, 1932, 89.) Thermophilic; cellulose decomposed quickly at 55° to 60°C, more slowly at 37°C.

Cellulobacillus myzogenes Simola (loc. cit.). Not slimy as above.

Clostridium pelatinosum Laxa. (Eine thermophilen Baculus, Laxa, Cent. f. Bakt., II Abt., 4, 1803, 362; Laxa, ibd. 6, 1900, 286; 8, 1902, 154; Bacterium sacchariphilum Migula, Syst. d. Bakt., 2, 1900, 341; Bacterium lazar Chester, Man. Determ. Bact., 1901, 187.) From sugar factory wastes. Produces slime in sucrose solutions. Probably a variety of Bacillus vulgatus according to Sacchetti (Cent. f. Bakt., II Abt., 28, 1936, 1193.

Denitrobacterium thermophilum Ambroz. (Cent. f. Bakt., II Abt., \$7,1913, 3.) From soil.

Lactobacillus sporogenes Horowitt-Wlassowa and Nowotelnow. (Cent. f Bakt., II Abt., 87, 1933, 331.) Resembles Lactobacillus delbrueckii but forms ellipsoidal, terminal spores.

Metabacterium polyspora Chatton and Perard. (Compt. rend. Soc. Biol., Paris. 5, 1913, 1232.) The type species of the genus Metabacterium, characterized by forming one to eight spores in a single cell. From the caccum of guines pigs. See Buchanan (Jour. Bact., 3, 1918, 3). Myxobacillus betue Gonnerman. (Ocsterreich-Ungarische Ztschr. f. Zackerind. u. Landuirtsch., 35, 1907, 877. see Cent. f. Bakt., II Abt., 21, 1903, 253) Produces slime in sucrose solutions. Appears to be closely related to Bactilus subtitis.

Nitrosobacillus thermophilus Campbell. (Science, 75, 1932, 23.) A thermophilic aerobic rod with swollen clavate sporangia; forms nitrites from ammonium salts. From surface layers of soil from North Carolina and Florida.

Semiclostridium commune, S. cutreum, S. flavum and S. rubrum Maassea. (Arbt. a. d. biol. Abt. f. Laad- u. Forstwirtsch. am kaiserl. Ges. Amt., §, 1907, 1.) Produce slime in sucrose solutions.

## Genus II. Clostridium Prazmouski.\*

(Prazmonski, Untersuchungen über die Entwickelungsgeschiehte und Formantwirkung einiger Bacterien-Arten, Inaug. Diss. Leinzig, 1880, 23: Vibria Müller. Vermium terrestrium et fluviatilum t 1773 39: Racterium Ehrenhere Evertebrote Berlin, 1828, (87) \*\*: Metallacter Perty, Zur Kenntniss kleinster Lebensformen, 1859. (1807): Amulobacter Trecul, Compt. rend. Acad. Sci., Paris, 61, 1865, 435; Bacillus Cohn. Bestr. z. Biol. d. Pflanzen J. Heft 2, 1872, 175; Twrothriz Duclaux, Ann. Inst. Nat. Agron., 4, 1882, (797). Paganta Trevisan, Atti della Accad. Fig.-Med.-Statist. Milano, Ser. 4, 5, 1885. (837). Cornilia Trevisan, I genera e le specie delle Batteriacee. Milano, 1889, 21: Granulobacter Benerinck, Verhandt, d. k. Akad, v. Wetensch. Amsterdam, Tweedie Sect., Deel I. 1893, 4: Bactridium, Paraplectrum, Diplectridium and Plectridium Fischer, Jahrb f Wissensch Botan , 27, 1895, 139, Granulobacillus Schattenfroh and Grassberger, Cent f Bakt , II Abt , 5, 1899, 702: Streptobacullus Rist and Khoury, Ann. Inst. Past . 16, 1902, 70; Botulobacillus, Buturibacillus, Cel-Iulobacillus, Putribacillus and Pectobacillus Orla-Jensen, Cent f Bakt., II Abt., 22. 1000. 342-343: Pectinobacter Makrinov, Arch Sci Biol (Russ.), 18, 1915, 442; Bacteroides Castellani and Chalmers, Man, of Trop Med , 3rd ed., 1919, 953; Buturiclastridium and Putriclostridium Orla-Jensen, John Bact. 6, 1921, 263: Ricoltillus and Metchnikovillus Heller, Jour Bact . 6, 1921, 550, Omelianskillus, Macintoshillus, Douglasillus, Henrillus, Flemingillus, Vallorillus, Multifermentans, Hiblerillus, Welchillus, Stoddardillus, Arlongillus, Meverillus, Novillus, Seguinillus, Reolillus, Robertsonillus, Nicollaierillus, Martellillus, Recordillus, Tissierillus, Putrificus Ermengemillus and Weinbergillus Heller, Jour Bact . 7, 1922, 5-9; Pentoclostridium Donker, Inaug Diss , Delft, 1926, 23. Botulinus, Chauvoea and Welchia Pribram, Jour. Ract. 18, 1929, 374. Angeropacillus, Verrucosus and Euclostridium Janke, Cent. f. Bakt . II Abt . 80, 1930, 490; Butulobacter Bakonvi. U.S. Letters Pat . 1.818,782, 1931; Caduceus, Endosporus, Inflabilis, Palmula and Terminosporus Prévot, Ann. Inst. Past . 61, 1938, 76-86, Acuformis (syn Palmula) Prévot, Man d Class., etc., 1940. 152.) From Greek, closterdium, a little spindle

Rods, frequently enlarged at sporulation, producing clostridial or plectridial forms. The cells possess no catalase. Anserobic or microserophilic Biochemically very active Many species forment carbohydrates producing various acids (frequently including butyric) and gas (CO, II, and sometimes CH.). Others cause rapid putrefaction of proteins producing offensive odors. Commonly found in soil and in human or animal feces. Some species, while growing asprophytically on decomposing vegetable matter or on dead tissue within an animal host, form various toxic and lytic substances and are thereby nathecenic.

The type species is Clostridium buturicum Prazmowski.

Ken to the species of genus Clostridium.

- I Strictly anaembic.
  - A Not typically fermenters of cellulose.
    - 1 Do not characteristically produce distinctive pigments.
      - a. Spores central, excentric, to subterminal.
        - b. Spores oval.

<sup>\*</sup> Revised by Prof R. S. Spray, School of Medicine, West Virginia University, Morgantown, West Virginia, November, 1938; further revision May, 1942

<sup>\*\*</sup> In a few instances the original records were inaccessible. In such cases the page is indicated as (8?). In all other cases the page indicates what is believed to be the earliest record of the designation cited.

- c. Rods distinctly swollen at sporulation.
- d. Motile
  - e. Gelatin, or glucose gelatin, not liquefied.
    - f. Glucose fermented.
      - g Congulated albumin not liquefied.
        - h. Stormy fermentation, or at least active coagulation of milk. Also see hhh.
          - i. Glycerol not fermented.
          - i. Mannitol fermented.
            - k. Starch, lactose and sucrose fermented. 1. Clostridium buturicum
            - kk. Starch not fermented. Lactose and sucrose fermented
              - 1a. Clostridium beijerinckii.
          - ii. Mannitol not fermented.
            - k. Starch and lactose not fermented. 1b. Clostridium nasteurianum
          - ii. Glycerol fermented.
            - i. Mannitol not fermented.
              - k. Starch, lactose, sucrose and salicin fermented 1c. Clostridium multifermentans.
        - hh. Milk slowly congulated; not stormily. Also see hhh
          - Glycerol and mannitol not fermented.
          - 2. Clostridium fallax. ii. Glycerol not recorded.

            - j. Acid, but no gas, from lactose and sucrose. 3. Clostridium fissum.
    - hhh. Milk not coagulated.
      - i. Glycerol not fermented.
    - 4. Clostridium difficile. gg. Coagulated albumin not recorded.
      - h. Milk acidified, but not coagulated.
  - 5. Clostridium viscifaciens. ee. Gelatin, or glucose gelatin, liquefied.
    - f. Glucose fermented.
      - g. Coagulated albumin not liquefied.
        - h. Milk slowly coagulated. Clot not digested.
          - i. Glycerol and mannitol not fermented.
            - i. Lactose fermented.
              - k. Sucrose not fermented. Salicin fermented. 6. Clostridium septicum.
              - kk. Sucrose fermented. Salicin not fermented 7. Clostridium feseri.
          - ii. Glycerol fermented.
          - 8. Clostridium hemolyticum.
      - hh. Milk acidified but not coagulated.
        - Glycerol fermented.
          - j. Mannitol not fermented.
            - k. Starch fermented Lactose, sucrose and salicin

not fermented Evotovin formed; toxic on injection but not on feeding. 9. Clostridium novy:

kk Starch not recorded.

l Lactose, sucrose and salicin not fermented m Adonitol fermented

10. Clostridium batulinum mm Adonitol not fermented.

10a Closiridium botulinum, Type C

gg. Coagulated albumin slowly to rapidly liquefied.

h. Stormy fermentation, or at least active coagulation of milk Clot not digested.

11. Clostridium acetobutulicum.

hh Milk slowly and softly coagulated; not stormily. Clot slowly to rapidly digested

i Glycerol and mannitol not fermented Also see m. 1 Starch not recorded

k Lactose fermented

12 Clostridium aerofoetidum. kk. Lactose not fermented

13 Clostridium sporogenes.

13a Clostridium sporogenes var A P. Marie.

13b Clostridium sporogenes var equine

13c. Clostridium turosinogenes 13d. Clostridium flabelliferum

13e. Clostridium parasporogenes

n Giveerol fermented Also see m i. Mannitol not fermented.

> 14 Clostridium parabotulinum Types A and B

in. Giveerol not recorded.

1 Mannitol and starch not recorded. k. Lactose and sucrose weakly fermented

> Gas formed from carbohydrates. 15 Clostridium saccharolyticum

Il Gas not formed from carbohydrates 16 Clostridium regulare.

ff Glucose not fermented. (Carbohydrates not fermented.)

g Coagulated albumin not digested. Lab-coagulation of . milk, increasing alkalinity. Clot digested. 17. Clostridium hastiforme.

gg, Coagulated albumin not recorded. Slow, mildly acid coagulation of milk. Clot digested.

18. Clostridium subterminale

dd, Non-motile

e. Gelatin, or glucose gelatin, not liquefied

19 Clostridium malenominatum

cc Rods not swollen at sporulation

- d. Motile.
  - e. Gelatin, or glucose gelatin, liquefied,
    - f. Glucose fermented.
      - g. Congulated albumin liquefied. Milk slowly congulated Clot slowly directed
        - 20. Clastridium bifermentans.
    - gg. Congulated albumin not recorded
      - h. Milk slowly congulated; slimy.
        - i. Gas formed from glucose.
          - 21. Clostridium mucosum.
      - ii. Acid but no gas from glucose. 22. Clostridium pruchii.
  - ce. Iron-gelatin (Spray), no growth.
- 23. Clostridium culindrosporum.
- dd. Non-motile c. Gelatin, or glucose gelatin, liquefied.
  - f. Glucose fermented
    - g. Coagulated albumin not liquefied.
      - h. Milk stormily fermented. Clot not digested.
        - i. Glycerol fermentation variable.
          - i. Mannitol not fermented. Starch, lactose and sucrose fermented. Salicin rarely fermented. Types identified by specific toxin-antitous neutralization.
            - 24. Clostridium perfringens Types A. B. C and D.
- bb. Epores er herical.
  - c. Rods distinctly swollen at sporulation.
    - d. Motile.
      - e. Gelatin, or glucose gelatin, not liquefied.
      - f. Glucose fermented.
        - g. Coagulated albumin not liquefied.
          - h. Milk acidified; slowly and softly coagulated; not stormily. Clot not digested.
            - 25. Clostridium sphenoides.
        - hh. Milk acidified but not coagulated.
          - 26. Clostridium innominatum.
  - cc. Rods not swollen at sporulation.
    - d. Non-motile.
      - e. Gelatin, or glucose gelatin, not liquefied.
        - f. Glucose fermented.
        - g. Coagulated albumin not liquefied.
          - h. Milk acidified but not coagulated. 27. Clostridium filiforme.
- aa. Spores terminal. b. Spores distinctly oval to ellipsoid.
  - c. Rods distinctly swollen at sporulation.
    - d. Matile.
      - e. Gelatin, or glucose gelatin, not liquefied. Also see eee.
        - f. Glucose fermented

- e. Conculated albumin not liquefied.
- h. Milk slowly congulated. Clot. not divested.
  - i Giverni not fermented.
    - i. Mannitol fermented.
      - 28. Clostridium sartagoformum.
- ii. Mannitol not fermented.
  - 20 Clostridium paraputrificum
- ff. Glucose not formented
  - g. Congulated albumum not liquefied. Milk unchanged
- 20 Clastridium cachlearium or Cosmilated allumin not recorded.

  - h Milk, or iron-milk (Spray), no growth
  - . Carbohydrates not formented.
    - i. Ethyl alcohol fermented chiefly to caproic seid. 31 Clostridium kluimerii.
    - ii. Ethyl alcohol not fermented to caproic acid.
    - 32 Closterdium acidineres.
- ce. Gelatin, or glucose gelatin, liquefied. Also see eec. f Glucose formented
  - g. Congulated albumin liquefied.
    - h. Milk often, but not always, coagulated. Clot. if formed, not digested.
      - 33 Clostridium camtovale.
    - hh. Milk acidified but not coagulated. Slow pentoniza
      - i. Giveerol and mannitol not recorded.
        - i. Starch not fermented.
- 31 Clostridium parabifermentans. eee, Gelatin, or glucose gelatin, not recorded. Glucose fermented
  - ii. Starch not recorded. Lactose weakly fermented. 35 Closterdium ovalare.
- with acid but no gas.
- 36 Clostridium zoonleicum. bb. Spores spherical, or nearly so
  - c. Rods distinctly swollen at sporulation
    - d. Motile
      - e. Gelatin, or glucose gelatin, not liquefied. Also see ece.
        - f. Glucose fermented.
          - g Congulated albumin not liquefied
            - h. Milk slowly coagulated, not stormily. Clot hot digested. Also see hhh.
              - 37 Clostridium thermosaccharolyticum.
          - hh. Milk not coagulated, unchanged. Also see hhh. 38 Clostesdium caloritolerans.
          - bbh Milk slowly alkalinized; casein slowly separated. 39 Clustridium tetanoides.
    - ee. Gelatin, or glucose gelatin, liquefied. Also see eee.
      - f. Glucose not fermented.

g. Coagulated albumin slowly liquefied.

h. Milk may show soft lab-coagulation. Clot not definitely digested.

40. Clostridium tetani.

bh. Milk shows slow, soft lab-coagulation. Clot slowly digested.

41. Clostridium lentoputrescens.

ff. Glucose weakly fermented.

g. Coagulated albumin slowly liquefied.

h. Milk variably coagulated. Clot, if formed, variably digested.

42. Clostridium filamentosum.

eee. Gelatin records at variance.

f. Glucose fermented

e. Coagulated albumin not liquefied.

Milk not coagulated: unchanged.

43. Clostridium tetanomorphum.

dd. Non-motile.

e. Gelatin, or glucose gelatin, not liquefied. f. Glucose fermented.

e. Congulated albumin not recorded.

44. Clostridium alcalinenes. ee. Gelatin, or glucose gelatin, liquefied.

f. Glucose fermented.

g. Coagulated albumin not liquefied,

45. Clostridium angulosum.

gg. Coagulated albumin liquefied, 46. Clostridium putrefaciens.

2. Characteristically produce pigments of varied colors.

a. Spores central, excentric, to subterminal.

b. Spores oval.

c. Rods distinctly swollen at sporulation.

d. Motile. e. Gelatin, or glucose gelatin, not liquefied.

f Black pigment formed around colonies in deep agar.

47. Clostridium nigrificans.

ff. Violet pigment formed in potato mash.

g. Indole is formed.

48. Clostridium belfantii.

gg. Indole is not formed.

48a. Clostridium maggiorai.

fff. Green pigment formed on potato slant.

g. Indole is formed 48b, Clostridium derossii.

48c. Clostridium ottolenghii.

48d. Clostridium paglianii.

gg. Indole is not formed. 4Se. Clostridium lustigii.

48f, Clostridium sciaros.

- ffff. Red pigment formed in potato mash.
- g. Indole not recorded.
  - 49. Clostridium venturelli.
- ce. Gelatin, or glucose gelatin, liquefied.
- f. Red to orange-red pigment formed, especially in starchy media.
  - g Indole is not formed.
    - b. Stormy fermentation of milk. Clot slowly softened.
    - 50. Clostridium roseum.
  - hh. Slow, spongy coagulation of milk. Clot slowly digested. 51 Clostridium chromogenes.
  - ff. Yellow-orange pigment formed in various media.
  - g. Indole is not formed
    - h. Milk actively coagulated, not stormily. Clot is not digested
      - 52 Clostridium felsineum
- as Spores terminal. b. Spores oval.
  - c. Rods distinctly swollen at sporulation.
  - d Non-motile
    - e Gelatin, or glucose getamın, no liquefied
      - f. Deep red pigment formed on potato slants 53 Clostridium carbonei.
- B Typical fermenters of cellulose. 1. Do not characteristically produce distinctive pigments
  - a. Spores terminal.
    - b Spores distinctly oval to ellipsoid
      - c. Rods distinctly swellen at sporulation
        - e. Gelatin, or glucose gelatin, liquefied. Ferments a variety of carbohydrates, other than cellulose, after prolonged cultivation
          - 54 Clostridium spumarum.
        - ee. Gelatin, or glucose gelatin, not recorded Carbohydrates, other than cellulose, not fermented 55 Clostridium scerners.
    - bb. Spores spherical, or nearly so.
    - c. Rods distinctly swollen at sporulation d. Non-motile.
      - 56 Clostridium cellulosoliens
  - 2 Characteristic pigments produced in certain media a Spores terminal.
    - b. Spores distinctly eval to ellipsoid. Rods distinctly swellen at sporulation.
      - 57 Clostridium dissolvens,
      - bb Spores spherical, or nearly so. Rods distinctly swollen at sporulation.
        - 58. Clostridium omelianskii.

II. Microaerophilic. Grow customarily as anaerobes, but are able to produce scan sometimes atypical, growth on aerobic agar slants.

A. Not typically fermenters of cellulose.

- 1. Do not characteristically produce distinctive pigments.
  - a. Spores central, excentric, to subterminal. Spores oval. Rods dis tinctly swollen at sporulation.

ec. Gelatin, or glucose gelatin, liquefied.

as. Spores terminal. Spores distinctly eval to ellipsoid. Rods distinctly swollen at sporulation.

61. Clostridium tertium.

mentation; clot fragmented but not digested.

Indole not formed.

Nitrites not produced from nitrates.

Fixes atmospheric nitrogen.

Acid and gas from xylose, glucose, lactose, sucrose, starch, salicin, esculin and mannitol. Amygdalin, pectin, cellulose, giveerol and Ca-lactate not fermented.

Fermentation products include butyl, ethyl and iso-propyl alcohols, acetone,

organic acids, H2 and CO2. Congulated albumin not liquefied.

Blood serum not liquefied.

Brain medium not blackened or digested.

Non-pathogenic for guinea pig and eabbit.

Grows well from 30°C to 37°C.

Anaerobie.

Source : Originally isolated from cheese. Commonly encountered in naturally soured milk, in naturally fermented starchy plant substances and in soil.

Habitat: Probably rather widely dispersed in soils rich in humus.

Note: Many butyric acid-producing anaerobes are recorded in the literature. The questionable purity and the incomplete descriptions, particularly of the older species, make it difficult to determine the degree of relationship of these species to Clostridium butyricum Praz-The following list cites the outstanding historic or recently described species.

59. Clostridium carnis.

f. Carbohydrates not fermented. 60. Clostridium histolyticum.

 Clostridium butyricum Prazmowski. (Untersuch, 6. d. Entwickelungsgeschischte u. Fermentwirk, einiger Bacterien-

Arten, Inaug. Diss., Leipzig, 1880, 23; Bacillus butyricus Flügge, Die Mikroorg., 2 Aufl., 1886, 206.) From M. L., acidum buturicum, butyric acid.

by the studies of Adamson, Jour. Path.

Described from the original incomplete records of Prazmowski, as amplified

and Bact., 22, 1919, 371, and of Hall, Jour. Inf. Dis., 50, 1922, 467.

Rods: 0.7 by 5.0 to 7 0 microns, straight or slightly curved, with rounded ends, occurring singly, in pairs, in short chains and occasional long filaments. Motile. Spores oval, excentric to subterminal, swelling rods to clostridial forms. Grampositive, becoming Gram-negative.

Granulose positive in clostridial stage (blue color with iodine).

Gelatin and glucose gelatin: Not liquefied.

Plain agar slant (anaerobic): Little or no growth.

Glucose agar surface colonies (anaerobic): Circular or slightly irregular, slightly raised, moist, creamy-white.

Deep glucose agar colonies: Biconvex, dense, yellowish-white, entire. Agar fragmented early by abundant gas.

Blood agar not hemolyzed.

Plain broth Little or no growth. Glucose broth. Abundant, diffuse turbidity; much gas.

Litmus milk: Acid and early coagulation. Litmus is reduced. Stormy fer-

Ferment butyrique, Pasteur, Compt. rend Acad Sci Paris 58 1861 315 (Vibrion butyrious, Pasteur, shid , 1261): Bacillus amulobacter van Tieghem, Bull. de la Soc Botan de France 21 1877 128 (Metallacter amulabacter Trevisan, Reale Ist Lombardo d. Sci. e Lett . Rendiconts. 1879, 147: Clostridium amylobacter Holland, Jour. Bact. 5, 1920, 217), Bacterium navicula Reinke and Berthold. Untersuch a d Bot Lab. d. Univ. Göttingen, 1, 1879, 21 (Amulobacter navicula Wehmer, Cent. f. Bakt., II Abt . 4. 1898, 696. Racillus nameula Chester. Ann. Rept. Del. Col. Agr Exp. Sta . 10. 1898. 128: Clostridium naviculum Prévot. Ann. Inst. Past., 61, 1938, 80): Bacillus butulicus Fitz, Ber. d Deuts Chem Gesellsch . 15, 1882, 867 (Bacterium fitz Buchner, Ztschr. f. Physiol, Chem. 9, 1885, 384); Butylbacillus, Buchner, shid., 391, Clostridium butyricum (Bacillus amylobacter) I. II. III, Gruber, Cent. f. Bakt., 1, 1887, 370-371; Bacillus butulicus Migula, Svst d. Bakt , 2, 1900, 598 (Clostridium buturicum I. Gruber, Cent f. Bakt . 1, 1887, 370), Bacillus oruberi Migula, loc cit., 599 (Clostridium buturicum II. Gruber, loc cit., 371); Bacıllus subanaerobius Migula, loc. cit., 600 (Clostridium butyricum III, Gruber, loc. cst , 371); Bacille amylozyme, also bacille amylocyme, Perdrix, Ann Inst. Past., 5, 1891, 290 (Bacillus amulozuma Migula, Syst. d. Bakt , 2, 1900, 626; Bacillus amylozymicus Peterson, Scott and Thompson, Biochem Ztschr. 219, 1930, 1: Clostridium amulozume Prévot, Ann. Inst. Past . 61, 1938, 79, Clostridium var amylozyme Prévot, Man d. Class , etc , 1910, 109), Bacillus orthobutulicus Grimbert, Ann. Inst Past . 7, 1893, 353, Granulobacter butylicum Beijerinck, Verhandl d K Akad. v Wetensch., Amsterdam, Tweedie Sectie, Deel I, 1893, 3 (Clostridium butylicum Donker, Thesis, Delft, 1926, 149; Amylobacter butylicum van Beynum and Pette, Cent f Bakt, H Abt, 93. 1935, 200, this species is probably identical with Clostridium buturicum I Gruber Cent. f. Bakt., I Abt., 1, 1887, 370); Granulahacter saccharobuturieum Rei serinck, loc. cit., 3, also in Arch. Neerland. d Sci. Exactes et Nat., 29, 1896, 1 (commonly identified with Bacillus butulicus Fitz, Ber d Deuts, Chem. Gesellsch., 15, 1882, 867: Racillus humosus Migula, Syst d Bakt . 2, 1900. 600: Clastridium saccharobuturicum Donker, Thesis, Delft, 1926, 147: Amulobacter saccharobutyricus van Bevnum and Pette, Cent. f. Bakt., II Abt. 98 1935. 200): Bacillus saccharobuturious von Klecks, Cent. f. Bakt . II Abt. e 1896, 169, Bactridium buturicum Chudia. kow. Zur Lehre von der Angerobiose (Russ.), Teil I, 1896, (?), cited by Rothert. Cent. f. Bakt., II Abt., 4, 1898, 300 Granulobacillus saccharobuturicus mobilis non-Lowefaciens Schattenfroh and Grass. berger, Cent f Bakt, II Abt., 5, 1899. (benegliche Buttersäurebacillus Grassberger and Schattenfroh, Arch. f. Hyg , 42, 1902, 219, Bacillus saccharobuturicus mobilis Hopfie, Ztschr. Infekrnkh d Haust., 14, 1913, 396; Bacillus amulobacter mobiles Gratz and Vas. Cent. f Bakt . II Abt . 41, 1914, 509); Plectridium vectinoiorum Störmer, Mitteil. d. Deuts, Landwirts, Gesellsch., 18. 1903, 195 (Microbe du rouissage, Winogradsky, Compt rend Acad. Sci., Paris, 121. 1895. 744. Granulobacter pectinocorum Beijerinck and van Delden, Arch. Néerland d Sci Exactes et Nat., Ser. II. 9, 1904, 423; Clostridium pectinocorum Donker, Thesis, Delft, 1926, 145); Bacil. lus holobulyricus Perdrix, Compt rend. Soc Biol , Paris, 57, 1904, 481; Bacillus amylobacter Bredemann, Cent. f. Bakt . II Abt , 25, 1909, 385 (Clostridium amulobacter Prévot, Ann Inst. Past., 61, 1938. 79). Amulobacter nonliquefaciens Ruschmann and Bavendamm, Cent. f. Bakt., II Abt , 64, 1925, 359; Clostridium intermedium Donker, Thesis, Delft, 1926, 147 (Strain No. 3, Donker, sbid., 39); buturicum Clostridium iodophilum

Svartz, Jour. Inf. Dis., 47, 1930, 138 (Clostridium iodophilum Prévot, Ann. Inst. Past., 61, 1938, 80); Granulobacter saccharobutyricus immobile nonliquefa-McCoy, Fred, Peterson and ciens Hastings, Jour. Inf. Dis., 46, 1930, 121; Bacillus amylobacter S and W, Wertheim, S. Letters Pat., 1,917,676, 1933; Clostridium tyrobutyricum van Beynum and Pette, Cent. f. Bakt., II Abt., 98, 1935, 208; Clostridium polyfermenticum. Clostridium saccharopetum, Clostridium saccharophilicum and Clostridium saccharopostulatum Partansky and Henry. Jour Bact., 30, 1935, 564.

1a. Clostridium beijerinckii Donker. (Donker, Thesis, Delft, 1926, 145.) Named for M. W. Beijerinck, the Dutch bacteriologist.

Has the general characters of Clostridium bulyricum

Distinctive character: Non-fermentation of starch.

Acid and gas from glucose, lactose, sucrose, inulin, galactose, fructose and manuitol Glycerol and starch not fermented.

Source From soil and fermenting plant tissues.

Habitat · Apparently widely distributed in agricultural soils

1b. Clostridium pasteurianum Winogradsky. (Winogradsky, Arch Sci Biol. (Russ.), 5, 1895, 330, Clostridium pastorianum Winogradsky, Cent f Bakt., II Abt., 9, 1902, 43, Bacillus pasteurianus Lehmann and Neumann, Bakt. Diag, th Aufl., 2, 1907, 82; Bacillus pasteurianus Lehmann and Neumann, tbid., 462, not Bacillus pastorianus Mack, Traité Prat. I Bact., 4th ed., 1901, 957, Bacillus unogradsky: Weinberg et al. Les Mirobes Annér., 1937, 645) Named Iordus Pasteur, the French scientist.

Probably related species. Bodily, Univ. Colorado Studies, 26, 1938, 30, records 5 new species isolated from 10 strains received labeled C. pasteurianum. These have been designated as Bacillus dulcito-fermentans, Bacillus rhamnoticus, Bacillus inulofugus, Bacillus nonpentosus and Bacillus azoticus.

Has the general characters of Clostridium butyricum.

Distinctive characters: Prolonged retention of the spore within a peculiar brush-like spore-capsule, and the nonfermentation of starch. Assimilates free atmospheric nitrogen.

Distinguished from Clostridium besjerinckii by the non-fermentation of lactose and mannitol, and from Clostridium butyricum by the non-fermentation of starch.

Acid and gas from glucose, sucrose, inulin, galactose, fructose and devtria. Glycerol, starch, lactose and mannitol not fermented.

Source: Originally isolated from soil. Habitat: Not determined, but apparently of restricted and local distribution in soil.

1c. Clostridium multifermentams Bergev et al. (Bacillus multifermentams tenalbus Stoddard, Lancet, J, 1912, 12; Multifermentams tenalbus Heller, Jour. Bact., 7, 1922, 6; Bergey et al., Manual, lat ed., 1923, 324.) From Latin, multus.

many, and fermentans, fermenting.

Has the general characters of Clostridium butyricum, and is probably only a variety.

Distinctive character Blood sgar colonies show a zone of hemolysis in 24

colonies show a zone of hemolysis in 2 hours Nitrites are produced from nitrates

Distinguished from Clostridium butyricum by the above characters and by the fermentation of glycerol and nonfermentation of mannitol

Distinguished from Clostridium beijerinckii by the fermentation of starch and of glycerol.

Distinguished from Clostridium pasteurianum by fermentation of starch and of lactose. Acid and gas from glucose, fructose, galactose, maltose, lactose, sucrose, raffinose, starch, salicin, inulin and glycerol Mannitol and dulcitol not fermented

Source: Originally isolated from human gaseous gangrene.

Habitat: Found in soil and mulk Widely distributed in nature

 Clostridium fallar (Weinberg and Seguin) Bergey et al. (Bacille A, Weinberg and Seguin, Compt. rend Soc. Biol., Paris, 78, 1915, 277; Bacillus fallar Weinberg and Seguin, 4bid, 686; not Bacillus fallar Ornstein, Zischr. f Hyg, 91, 1920, 159, Vallorillus fallar Heller, Jour. Bact., 7, 1922, 6, Bergey et al., Manual, 1st ed., 1923, 325) From Latin, fallar, deceptive.

Rods. 0 6 by 1 2 to 5 0 microns, occurring singly or rarely in pairs. Mottle with pertitribous flagella Encapsulated in body fluids. Spores rarely observed, oval, excentric to subterminal, swelling rods. Gram-coattive

Gelatin not liquefied

Glucose agar surface colonies (anaerobic): Circular, flat, with transparent,

crenated margin
Glucose agar deep colonies Lenticular,
bean-shaped, irregular, smooth.

Agar slant (anaerobic). Grayish film Broth Poor growth; slight diffuse turbidity.

Glucose broth Abundant turbidity and gas Clearing by sedimentation

Indole not formed (Duffett, Jour Bact., 29, 1935, 576)

Litmus milk: Acid, slowly coagulated Litmus reduced Clot channeled by gas, but not digested

Acid and gas from glucose, galactose, fructose, maltose, lactose, sucrose, nulin, salicin and starch Glycerol and mannitol not fermented Records vary in regard to action on lactose, inulin and

Coagulated albumin not liquefied Blood scrum not liquefied

Brain medium not blackened or digested. Meat medium reddened; not blackened or digested.

Pathogenicity for gumea pig variable, and commonly lost in cultivation Forms a weak evotorin

Optimum temperature not recorded; grows well at 37°C.

Anaerobic.

Source: From war wounds, appendicitis, and once from black-leg of sheep Habitat: Not determined, other than these sources

3. Clostridium fissum (Debono) Bergey et al. (Bacillus fissus Debono, Cent. f. Bakt., I Abt., Orig., 68, 1912, 232; Bergey et al., Manual, 1st ed., 1923, 332) From Latin, fissum, separated

Rods Variable in size, rounded or square ends, occurring singly, in pairs and in chains and filaments. Motile Spores small, oval, subterminal, slightly swelling rods. Gram-positive.

Gelatin · Not liquefied

Deep gelatin colonies at 22°C: Small, brownish, globular, opaque and entire Deep glucose agar colonies: Small, white, globular Gas is formed No

pigment formed.
Broth Uniformly turbid

Milk: Acid, coagulated after 3 days Indole not formed.

Acid and gas from glucose Acid only in lactose and sucrose

Coagulated albumin not liquefied. Grows at 22°C and 37°C

Anaerobic.

Distinctive character All cultures smell strongly of butyric acid Source From human feces

Habitat Not determined, other than

this source
4 Clostridium difficile (Hall and

4 Closindum unicile (that and O'Toole) Prévot (Bacillus difficilis Hall and O'Toole, Amer Jour Dis. Child, 49, 1935, 390, Clostrahum difficilis Prévot, Ann Inst. Past 61, 1938, 84) From Latin, difficilis, difficult.

Rods: Heavy-bodied. Actively motile

Spores elongate, subterminal slightly swelling rods. Gram-positive.

Gelatin: Not liquefied.

Blood agar surface colonics (anaerobic): Irregular, flat and non-hemolytic.

Deep agar colonies: Minute, flat, opaque disks, becoming lobate.

Milk: Poor growth. Gas formed in traces, but milk unchanged.

Acid and gas from glucose, fructose, mannitol, salicin and xylose. Traces of gas, but no acid, from galactose, maltose, sucrose, lactose, raffinose, inulin and glycerol.

Coagulated albumin not liquefied.

Blood serum not liquefied.

Brain medium with iron is moderately blackened. Digestion not recorded.

Pathogenic for guinea pig and rabbit. Subcutaneous inoculation induces marked edema. Death may occur in from 1 to 9 days.

Toxicity · Glucose broth culture filtrates kill guinca pig and rabbit in 21 to 26 hours.

Grows well at 37°C.

Annerobic.

Source: From feces of new-born infants.

Habitat Not determined, other than
this source.

5 Clostridium viscifaciens Sherman and Erb. (U.S. Pat., 2,017,572, 1935.) From Latin, viscus, birdlime, glue; faciens, making.

Rods: Vegetative cells 3 to 10 microns long; average about 6 microns Motile. Spores oval, 1 by 2 microns, central to subterminal, sometimes swelling rods to club-like and spindle-shaped cells. Gram-necative.

Granulose reaction positive.

Gelatin: Not liquefied.

Plain agar slant (anaerobic): No growth.

Plain agar stab : No growth.

Liquid media: Tendency toward flocculent growth.

Milk: Acidified but not congulated. Casein not digested.

Corn mash: Not fermented or digested. Indole not formed.

Nitrites produced from nitrates.

Ammonia produced from peptone.

Acid, gas and alcohols produced from glucose and maltose.

Acid and gas from sucrose, lactose, devtrin, starch, glycerol, mannitol and salirin.

Calcium lactate: Not fermented.

Fermentation products include butyl alcohol (66 parts), iso-propyl alcohol (31 parts), and small amounts of acetone (3 parts).

Limiting reaction for growth: About pH 4.0 to about pH 8.0.

Optimum temperature 32°C to 36°C. Grows from 15°C to 42 5°C.

Anaerobic.

Distinctive character: In fermentable sugar broths it produces a copious flocculum.

Source: From soil and from grains and other plant materials in contact with soil.

Habitat: Apparently widely dispersed in agricultural soils.

6. Clostridium septicum (Macé) ford. (Vibrion septique, Pasteur and Joubert, Compt. rend. Acad Sci., Paris, 85, 187, 113, and Bull. Acad Med., 2º Scr., 6, 1877, 794; Vibrio pasteurii Trevisan, Reade Ist. Lombardo d. Sci. e. Lett., Rendiconti, Ser. 2, te, 1879, 147; Barillus septicus Macé, Traité Prat. d. Bact., 1st ed., 1883, 455; not Bacillus septicus Migula, 5yst. d. Bakt., 2, 1000, 646 (Unnamed nerobie bacillus, Babes, Sept. Proc. d. Kindesalters, Leiprig, 1889, 32; Bacillus septicus ulceris gangraenati

<sup>\*</sup> Note. In an editorial, Jour. Amer. Vet. Med. Assoc., 62, 1922-23, 565, the name Clostrudium septicum is ascribed to Winslow et al., Jour. Bact., 5, 1929, 191. Search falls to confirm the reference Casual mention is not regarded as sufficient to establish priority. Hence, Ford is regarded as the author of this binomial

Sternberg, Man. Bact., 1893, 472); not Bacillus senticus Klein, Micro-organisms and Disease, 1884, 78: Cornilia pasteuri Trevisan, I coneri e le specie delle Batteriacee, 1880, 22: Bacillus senticus ganorenge Arloing, Lecons sur la tuberculose et certaines septicémies, Paris, 1892, 451. Vibringene sentique, Rosenthal, Compt. rend Soc. Biol., Paris, 64, 1908. 398; Vahria sentime Le Blave and Guerenhoum Man. Prat. d. Diag. Bact., 1914, 438. Rivoltillus vibrion Heller, Jour Bact . 7. 1922 6. Racillus parasarkonhusematas Micsaner, Cent. f. Bakt. I Abt. Orig. 89 (Bhft.), 1922, 126, and Deuts Tierarztl Webnschr . 30 1922, 416 (Racillus narasarcophysemalos Zeissler, Cent. f. Bakt. I Abt., Orig., 89 (Bhft ), 1922, 119). Vibrio septicus Rottgardt, Deuts Tierarzti Wehnschr., 34, 1926, 553, Ford, Textbook of Bact., 1927, 726, Clostridium senticus Scott, Cornell Vet . 18, 1928, 259. Clostridium sentique Topley and Wilson. Princ of Bact, and Immunol , 1st ed , 2, 1929, 1161.) From Greek, septicus, putrefactive, sentic.

Probable synonym: Bacillus of Ghon and Sachs, Cent. f. Bakt, I Abt, Orig. 54, 1903, 289.

Identical or closely related species Clostridium balgenge Prévot. Ann Inst Past , 61, 1938, 81 (Walfischseptikamie Bacillus, Nielsen, Cent. f. Bakt . 7, 1890. 269. Bacille de la septicémie de la baleine, Christiansen, Compt. rend Soc. Biol . Paris, 83, 1920, 324; Walfischbazillus, Christiansen, Cent. f Bakt . I Abt . Orig., 84, 1920, 127): Bacillus gastromycosis ores Kitt, Bakt, u Path Mikros , 2 Aufl., 1893, 239 (Bradsotbacillus, Nielsen, Monats. Prakt Tierhik . 8, 1897, 59), Bacillus tumefaciens Wilson, Lancet, 196, 1919, 657 (Clostridium tumefaciens Prévot, Ann. Inst. Past . 61, 1938, 81); not Bacillus tumefaciens Israilsky, Cent f. Bakt., II Abt., 67, 1926, 236; Bacillus seu Clostridium sarcophysematos boois Kitt, Bakterienkunde u Path, Mikros , 2 Aufl., 1893, 232 (Bacıllus sarcophyremaios Kitt, ibid., Index, X; not Bacillus sarcophysematos Zeissler, Cent. f. Bakt., I Abt., Orig , 89 (Bhft.), 1922, 119.) (See Clostridium (eseri.)

Confused in the older literature with Koch's bacillus of malignant edema, Mitt. a d kans. Geaudafts., 1, 1881, 54 (Bacillus odematts matigni Zopf, Die Spaltplus, 3 Auf, 1885, 88; (Catridum odematis malignis Fischer, Jahrb 1. Wissen. Bot., 27, 1805, (1467), Bacillus oedematis Schroeter, in Cohn's Kryptoganen-Florar v. Schlessen, 3, 1, 1886, 153, Clastridium edematis Holland, Jour. Bact., 5, 1920, 218, Clostridium edematis Holland, Jour. Bact., 5, 1920, 218, Clostridium odematis-maligni Bereve et al. Manual, 1st ed. 1923, 325).

It is commonly believed at present that Koch's bacillus of malignant edema was a culture of Clostridium septicum contaminated with Clostridium sporogenes or some closely related greanism.

Described from Weinberg and Seguin, La Gang. Gaz, Paris, 1918, 79, and from Hall, Jour Inf Dis, 30, 1922, 486.

Rods 0 to 0 8 by 3 0 to 80 microns, rounded ends, occurring singly, in pairs and in short chains in cultures, long chains and filaments commonly predominate in body crudates. Mottle, with pertirichous flagella. Spores oval, excentite to subterminal, swelling rods. Gram-ossitive.

Gelatin Liquefied, with gas bubbles. Agar surface colonies (anaerobic): Small, transparent, of variable shape.

Blood agar surface colonies (anaerobic): Delicate, flat, leaf-like, irregular Hemolytic

Drep agar colonies Variable, usually finely filamentous, cottony, spherical. Broth Slight, diffuse turbidity, with

clearing.

Litmus milk Litmus reduced, slow congulation and moderate gas Clot not

digested.

Indole not formed.

Nitrites produced from nitrates.

Acid and gas from glucose, fructose, galactose, maltose, lactose and salicin. Sucrose, multin, mannitol and glycerol not fermented (Hall, for cit, 489).

Coagulated albumin not liquefied. Blood serum not liquefied.

Brain medium not blackened or digested.

Meat medium reddened; not blackened or digested.

Pathogenic for guinea pig, rabbit, mouse and pigeon. Forms an evotoxin for which an antitoxin is prepared,

Optimum temperature about 37°C. Anaerobic.

Source: Originally isolated from animals inoculated with soil; later from malignant edema of animals, and from human war wounds and from appendicitis.

Habitat: Animal intestine, and in manured soils.

7. Clostridium feseri Trevisan, (Beweglichen Bakterien, Feser, Ztschr. f. Prakt. Vet.-Wissensch., 4, 1876, 19; Trevisan, Atti Accad. Fis.-Med.-Stat. di Milano, 3, 1885, 116; Bactersum chauvoei Arloing, Cornevin and Thomas, Le charbon symptomatique du bocuf, Paris, 2nd ed., 1887, 82; Bacillus chauvoci De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1004; Bacillus chauvaei Trevisan, I generi e le specie delle Batteriacee, 1889, 22; Bacillus fesers Kitt, Bacterienkunde, etc., 2 Aufl., 1893, 233; Bacillus anthracis symptomatici Kruse, in Flugge, Die Mikroorg, 3 Aufl., 2, 1896, 245; Bacillus carbonis Migula, in Engler and Prantl, Die natur. Pflanzenfam., 1, la, 1895, 26, Butyribacillus chauroei Orla-Jensen, Cent f Bakt., II Abt., 22, 1909, 342; Bacillus gangraenae emphysematosae Hutyra and Marck, Spez. Path. u Ther. d. Haust., 3 Aufl., 1, 1910, 39; Bacillus chauver Holland, Jour. Bact., 5, 1920, 217; Clostridium chaurei Holland, abid., 217, Bacillus anthracis-symptomatici Holland, ibid., 217; Clostridium anthracis-symptomatics Holland, 2bid, 217, Bacillus sarkophysematos Miessner, Cent f Bakt., I Abt., Orig., 89 (Bhft ), 1922, 123 (Bacillus sarcophysematos Zeissler, ibid , 119, not Bacillus sarcophysematos Kitt, Bakterienkunde, etc., 2 Aufl., 1893, Index, X); Bacillus symptomaticus Matouschek, Cent. f Bakt , II Abt., 58, 1923, 472; Clostridium chauroei Scott, Jour. Inf. Dis., 38, 1926, 262, Clostridium

chauraei Scott, Cornell Vet., 18, 1928, 259.) Named for Feser, an early German bacteriologist.

Possible synonyms: Bacterio ocello cuneato, Rivolta, Giorn. di Anat., Fisiol. e Patol. d. Animali, Piso, 14, 1882, 33, Bacillum cuneatum, Rivolta, ibid, 67, Bacillum ocello-cuncatum, Rivolta, ibid, 67; Bacterium cuneatum Rivolta, ibid, 77: Bacterium ocello cuneatum Rivolta, ibid., 78; Bacillus sarcophysematosi Peppler, Cent. f. Bakt , I Abt., 29, 1901, 354.

Rods: 1.0 by 3.0 to 8 0 microns, occurring singly, in pairs and in short chains. Usually show a dark chromatic point near each end. Motile with peritrichous flagella Spores oval, excentric to subterminal, swelling rods. Gram-positive.

Gelatin: Liquefied. Gas bubbles Agar surface colonies (anaerobic): Small, grayish, semi-opaque, filamentous. Agar slant (anserobic): Grayish,

spreading growth. Broth: Turbid, slightly peptolytic.

Litmus milk: Acid; slowly coagulated. Gas may be formed. Clot not digested Indole not formed (early studies record only a trace).

Acid and gas from glucose, fructose, galactose, maltose, lactose and sucrose Inulin, salicin, mannitol, glycerol and dextrin not fermented (Hall, Jour. Inf. Dis., \$0, 1922, 486).

Congulated albumin not liquefied. Blood serum not liquefied.

Brain medium not blackened or digested.

Egg-meat medium: Small gas bubbles in 8 hours. Ment becomes pinkish and the liquid slightly turbid. No blackening or digestion.

Pathogenic for guinea pig, mouse and rabbit. Forms an evotovin.

Optimum temperature 37°C. grow at 50°C.

Anacrobic

Source: The cause of black leg, black quarter or symptomatic anthrax in cattle and other animals.

Habitat: Probably soil; especially where heavily manured.

8. Clostridium hemolyticum (Hall) Hauduroy et al (Clostrudium hemolyticus bours Vawter and Records, Jour. Amer Vet Med. Assoc., 68 (N.S. 21), 1925-26, 512, Bacillus hemolyticus Hall, Jour Inf. Dis., 45, 1929, 156; Hauduroy et al., Dict. d. Bact. Path., 1937, 125.) From Greek, haemo. blood; tufticus, dissolvans.

Related species: Clostralum hemolyticum var. sordelli Hauduroy et al, loc. ct., 126 (Bacillus sp. (?), Sordelli, Prado and Ferrari, Compt rend So-Biol., Paris, 106, 1931, 142; Unnamed anaerobe of Matte, Inst. Biol. Soc. Nac. Agric., Chile, 2A, 1921, (317) (cited from Vawter and Records. loc. cti. 172)

Rods: 1.0 to 1.3 by 3.0 to 5.6 microns, with rounded ends, occurring singly, in pairs and in short chains. Motile with long peritrichous flagella Spores oval to clongate, subterminal, swelling rods. Gram-positive.

Gelatin: Liquefied.

Blood agar surface colonies (anaerobic). Light, diffuse growth. Blood hemolyzed.

Deep agar colonies: At first lenticular, becoming densely woolly masses with short peripheral filaments. Little or no gas formed.

Broth plus liver: Luxuriant diffuse turbidity, followed by agglutinative clearing. Moderate gas formed

Milk: Acid and slow coagulation. Clot not digested.

Asid and gas from glucose, fututose, galactose and glycerol. Lactose, maltose, sucrose, raffinose, arabinose, xylove, inulin, salicin, mannitol and dulcitol not fermented. Subsequent studies show that pure galactose is not fermented (Records and Vawter, Nevada Agr. Exp. Sta, Bull 173, 1945, 48 pa.

Indole is formed.

Methyl red and Voges-Proskauer tests are negative.

Nitrates are not produced from nitrates.

Hydrogen sulfide is produced The four characteristics given above are from Records and Vanter (loc. cst., 30)

Coagulated albumin not liquefied. Blood serum not liquefied.

Brain medium not blackened or digested.

Meat medium reddened, not blackened. No dizestion

Pathogenic and toxic for guinea pig and rabbit. Effect due to an unstable hemolytic toxin.

Grows well at 37°C

Anaembic

Source From blood and tissues of cattle dying of icterohemoglobinuria

Habitat Not determined. Thus far

9 Clostridium novyl (Migula) Bergey at al. (Bacillus oedematis maliani No. 11. Novy, Ztschr f Hyg., 17, 1891, 212; Bacillus oedematis thermophilus Kruse. in Flugge, Die Mikroorg., 3 Aufl., 2, 1896. 242, Bacillus novy: Migula, Syst d. Bakt., 2. 1900, 872. Bacterium ordematis thermophilus Chester, Ann Rept. Del Col. Agr Exp. Sta , 9, 1897, 126, Bacillus thermophilus Chester, Man Determ Bact., 1901, 265, Bacillus oedematiens Weinberg and Seguin, Compt. rend Soc. Biol, Paris, 78, 1915, 507 (Bacille B, Weinberg and Seguin, ibid , 177), Novillus maligni Heller, Jour Bact., 7, 1922, 7, Clostridium oedematiens Bergey et al. Manual, 1st ed , 1923, 326; Bergey et al., edem. Clostridium thermophilum Pribram. Jour. Bact , 22, 1931, 430; Clostridium novys Type A, Scott, Turner and Vanter, Proc. 12th Internat. Vet Congr., 2, 1934, 175 ) Named for F. G. Novy, the American bacteriologist who first isolated this organism

Related or possibly identical species: Newen pathogenen anaeroben Itacillus, Kerry, Osterr. Zischr f. Wiss. Veterinark. 5, 1894, 228; Bacterum nicosum LeBlaye and Gougenheim, Man Prat. d. Ding Bact, 1914, 344 (Bacille neigeux, Jungano, Compt. rend. Soc. Diol., Paris, 82, 1907, 6731-7); Basello nevoso, Jungnon, II Tommasi, 2, 1907, (7312); Gasödembazillus, Aschoff, Deuts. med. Webnschr, 24, 1916, 512; Bacille use bellonensia Sucquépée,

Compt. rend. Soc. Biol., Paris, 80, 1917. 850 (Bacille de l'ocdème gazeux malin, Sacquépée, 1bid., 78, 1915, 316; Clostridium bellonensis Prévot, Ann. Inst. Past., 61, 1938, 81); Bacillus gigas Zeissler and Rassfeld, Arch. Wiss. u. Prakt. Tierhlk., 59, 1929, 419 (Clostridium novvi Type B, Scott et al., loc. cit., 175; Clostridium gigas Prévot, Ann. Inst. Past., 61. 1938, 82); not Bacillus gigas Trevisan, Atti. d. Accad. Fis.-Med.-Stat., Milano. Ser. 4, 3, 1885, 96; Clostridium novyi Type C, Scott et al., loc. cit., 175 (nonpathogenic bacillus of ostcomvelitis of buffalo, Kraneveld, Nederl, Ind. Bl. Diergeneesk., 42, 1930, 564; Clostridium bubalorum Prévot, Ann. Inst. Past., 61. 1938, 82; Bacıllus osteomyelitis bubalorum Prévot, Man. d. Class., etc., 1940, 123).

Rods: 08 to 0.9 by 25 to 5.0 microns, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores large, oval, subterminal, swelling rods. Gram-positive.

ous. Grain-positive.

Gelatin Liquefied and blackened.

Agar surface colonies (anaerobic):

Small, white, with darker center,

Agar slant (anaerobic): Grayish,

spreading growth.

filamentous.

Deep agar colonies: Compact, opaque, becoming filamentous with age.

Broth. Turbid, with flocculent sediment.

Litmus milk: Acid, not coagulated. Litmus reduced.

Acid and gas from glucose, fructose, maltose, xylose, starch and glycerol. Lactose, sucrose, mannitol, dulcitol, inulin and salicin not fermented (Hall, Jour. Inf Dis , 30, 1922, 491).

C 1 1 1 1 min got liminfied

digested.

Pathogenic for guinea pig, rabbit, mouse, rat and pigeon. Forms an exotoxin, toxic on injection but not on feeding growth.

Optimum temperature 35°C to 38°C Anaerobic. Source: From a guinea pig inoculated with peptonized casein; later from gaseous gangrene.

Habitat: Probably occurs in manured soils.

10. Clostridium botulinum (Van Ermengem) Holland. (Bacillus botulinus Van Ermengem, Cent. f. Bakt, 1; Abt., 19, 1896, 443, and Ztschr. f. Hyg, 26, 1897, 48; Holland, Jour. Bact., 5, 1920, 217; Ermengemillus botulinus Helle, Jour. Bact., 7, 1922, 8.) From Latin, botulius, sausage; M.L., botulinus, relating to sausage.

Clostridium botulinum comprises a number of toxio species, conveniently divided by Bengtson, U. S. Public Health Serv., Hyg. Lab. Bull. 136, 1924, 33, and by Meyer and Gunnison, Jour. Inf. Dis., 45, 1929, 96 and 108, and by Gunnison and

num) group. Authorities are not yet in agreement on fermentations and on variant sub-types, and the present groupings are only tentative, and subject to revision. Meyer and Gunnison cite some 15 sub-types on the basis of toxicity, neglutination and fermentation.

The original Van Ermengem strain is not available, and his description is inadequate for classification purposes Description follows Bengtson (loc. et) who used Lister Institute Strain No. 49 (Brit. Med. Res. Counc., Spec. Rept. Ser. No. 12, 1917, 29; ibid., Spec. Rept. Ser. No. 1010, 290 as a type culture

Rods: 0.5 to 0 8 by 3.0 to 8.0 micros, with rounded ends, occurring singly, in pairs and in short to occasional long chains. Motile with peritrichous flagells. Spores oval, central, subterminal, to terminal at maturation, slightly swelling rods. Gram-positive.

Gelatin: Liquefied.

oг

Deep liver agar colonies: Fluffy with dense center.

Liver agar surface colonies (anaerobic). No perceptible growth. Broth : Scant or no growth.

Liver broth · Luxuriant turbidity, with considerable gas.

Milk: Slowly increasing acidity No

Acid and gas from glucose fructose

maltose, devtrin, glycerol, adonitol and inositol. Galactose, sucrose, lactose, raffinose, inulin, dulcitol, mannitol, xylose, arabinose, rhamnose and salien not fermented (Bengtson, loc. cit., 22-25)

Coagulated albumin not liquefied Blood serum not liquefied

Brain medium not blackened or

digested.

Meat medium not blackened or

digested
Pathogenic for animals. Forms a

powerful evotoxin which is neurotoxic both on injection and feeding Toxin is neutralized by Clostridium parabotulinum Type B antitoxin.

Optimum temperature 20° to 30°C (Van Ermengem, Ztschr. f. Hyg. 26, 1897, 42); 30°C (Van Ermengem, Arch d Pharmacodyn., 5, 1897, 213 and 499, see Williams and Reed, Jour Inf. Dis. 57, 1912, 227). Starm (Jour Inf. Drs. 53, 1926, 103), growth usually earlier at 37°C Toxin production probably best around 28°C.

Annembie

Source: Unknown. Culture received through Reddish from Robertson as Bacillus botulinus No. 94, Strain A, Institute of Infectious Diseases at Berlin. Similar strains have been isolated from canned foods.

Habitat: Probably occurs in soil.

10a Clostridium botulinum Type C (Tovin producing nancohe, Bengtson, U. S. Pub Health Repts., 27, 1922, 164 and 2525; Becilius botulinus Type C. Bengtson, 19td., 38, and U. S. Pub Health Serv, Hyg. Lab. Bull. 136, 1924, 7, Clostridium luciliza Bergey et al., Manual, 1st ed., 1923, 336.) From Latin, botulus, assusge.

Probably identical variety · Clostridium parabotulinum equi Theiler and Robinson, Rev. Gén de Med. Vet., 28, 1627, 190 (Clostridium botulirum Type E, Topley and Wilson, Principles of Baet and Immunol, 2nd ed, 1926, 688; Bacillus (Clostridum) botulirum D, Weinberg and Ginsbourg, Données Recentes sur les Mucrobes Ander, Paris, 1927, 107, but shown to be a Type C by Robinson, Union S. Africa, 16th Ann. Rept., Dir. Vet Sev. and Animal Indus, 1930, 126; not Clostridum botulirum Type D, Meyer and Gunnison, such infra). From a rat carcass presumably responsible for botulism pumping in South Africa.

Related varieties. Bacillus parabotulinus Seddon, Jour Comp Path and Therap, 35, 1922, 155 and 275 (Clostridium parabotulinum Ford, Text-Book of Bact, 1927, 743, although this name was used earlier in the "group" sense by Bengtson, U. S. Pub. Health Serv., Jhyg. Lab. Bull. 136, 1921, 32). First isolated from bones considered the source of "bubba parabuss" of eathie in Australia.

Clostradium parabotulunus bowis Theiler et al, Union S. Africa, Dept. Agric., 11th and 12th Repts. of the Dir. Vet. Educ. and Res., Part II, 1927, 1202 (Clostridium botulunum Type D., Meyer and Gunnison, Proc Soc Expt Biol. and Med., 26, 1932-29, 88, also Jour. Inf Dis., 45, 1929, 105; not Clostridium byte Dis., total Contradium botulunum Type D. Weinberg and Ginsbourg, side supra). From "lamziekte" of cattle in South Africa.

Clostridium botulnum Type E, Gunnison, Cummings and Meyer, Proc. Soc. Expt. Biol and Med, 55, 1936, 278 An organism received by them from the Russian Ukraine; source of isolation not stated

Clostradium botulinum Type C may be regarded as a variety of Clostridium botulinum, as it has morphologic and cultural characters very similar to those of the Van Ermengem strain. Only divergent or additional characters are recorded here.

Rods: 0 5 to 0.8 by 3 0 to 6 0 microns, commonly slightly curved.

Agar stab: Slight growth. No gas.

Brain medium blackened and digested. Meat medium reddened, then blackened and slowly digested.

Slightly pathogenic for guinea pig. Optimum temperature 30°C to 35°C. Anaerobic.

Source: From gaseous gangrene and from feces.

Habitat: Not determined other than these sources. Probably occurs in soil.

13. Clostridium sporogenes (Motchnikoff) Bergey et al. (Bacillus sporogenes
var. A, Metchnikoff, Ann. Inst. Past., 22,
1908, 944; Bergey et al., Manual, 1st ed.,
1923, 329; not Clostridium sporogenes
Holland, Jour. Bact., 6, 1920, 220 (Bacillus enteritidis sporogenes Klein, Cent. f.
Bakt., I Abt., 18, 1895, 737; Bacillus
sporogenes Migula, Syst. d. Bakt., 2,
1900, 560; Bacillus (enteritidis) sporogenes and Bacillus enteritidis Klein,
Local Govt. Bd., Ann. Rept. Med. Off.,
London, 33, 1903-04, 442 and 443.) From
Greek, sporus, seed; M.L., spore; genes,
producing.

Two varieties, A and B, were described. Bacillus sporogenes var. A, Metchnikoff, loc. cit., 944 (Metchnikovillus sporogenes Heller, Jour. Bact., 7, 1922, 9; Clostridum sporogenes var. A, Prévot, Ann. Inst. Past, 61, 1938, 83) is regarded as the typical form and is described here. Var. B, see Clostridium bifermentans.

Synonyms or probably related species: Oedembacillen, Koch, Mitt. a. d. kaiseri. Gesundheitsamte, f. 1851, 54; Baccillus oedematis matigni Zopf., Die Spaltpilze, 3 Aufl., 1885, 88 (not Bacillus oedematis matigni Liborius, Ztschr. f. Hyg., f. 1858, 185; Bacillus oedematis Migula, Syst. d. 1864, Bactlus oedematis Chester, Man. Determ. Bact., 1901, 292; Clostridium oedematis matigni Bergey et al., Manual 1st ed., 1923, 325 (see Species

Weigmann, Cent. f. Bakt., Il Aut., &, 1896, 155; Bacillus weigmanni Chester,

Man. Determ. Bact., 1901, 300; Pleetridium foetidum Weigmann, Mykologie der Milch, Leipzig, 1911, 70; Bacillus anaerobius foetidus LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914. 329: Endosporus foetidus Prevot. Ann. Inst. Past., 61, 1938, 75); Bacillus saprogenes carnis Salus, Arch. f. Hyg., 51. 1904. 114 (Bacillus saprogenes Salus, ibid., 115; not Bacillus saprogenes I. II. III. Herfeldt, Cent. f. Bakt., II Abt., I. 1895, 77; Bacillus carnis saprogenes Salus, Arch. f. Hyg., 51, 1901, 121; Plectridium saprogenes Prévot, Ann. Inst. Past., 61, 1938, 87); Bacillus sporogenes coagulans Debono, Cent. I. Bakt., I Abt., Orig., 63, 1912, 229 (Clostridium coagulans Bergey et al., Manual, 1st ed., 1923, 335); Reading Bacillus, Donaldson and Joyce, Lancet, 2, 1917, 448; Bacillus putrificus verrucosus Zeissler, Ztschr. f. Infkrnkh. u. Hyg. Haust., 21, 1920-21, 13 (Bacillus verrucosus Lehmann and Süssmann, in Lehmann and Neumann, Bakt, Diag., 7 Aufl., 2, 1927,

Rods: 0.6 to 0.8 by 3.0 to 7.0 micros, with rounded ends, occurring singly, in pairs, or less frequently in short to long chains and filaments. Motile with peritrichous flagella. Spores oval, excentic to subterminal, swelling rods. Grampositive.

Gelatin: Liquefied and blackened.

Agar surface colonies (anacrobie); Small, irregular, transparent, becoming opaque, yellowish-white, fimbriate.

Deep agar colonies: Woolly balls with dense, nodular center.

Agar slant (anaerobic): Grayish, opaque, spreading.

Blood agar is hemolyzed.

Broth: Turbid. Gas is formed. Putrid odor.

Litmus milk: Softly coagulated. Litmus reduced. Slow peptonization, leaving a dark, amber-colored liquid.

Indole formed (trace). Not formed (Hall, Jour. Inf. Dis., 39, 1922, 482). Nitrites not produced from nitrates.

Acid and gas from glucose, fructose,

alactose and maltose. Lactose, sucrose, alicin, glycerol, mannitol and inulin not ermented. (Records vary on many

ugars.)

Congulated albumin liquefied.

Blood serum liquefied to a dark, putrid
quid.

Brain medium blackened and digested. 'oul odor

Meat medium reddened, then blackned and digested with foul odor. Gas is

ned and digested with four outer. Gas is produced. Tyrosin crystals not obvious. Non-pathogenic to guines pig and rabnot, other than a slight, temporary local umefaction. Filtrate non-toxic on in-

ection and feeding. Optimum temperature 37°C. Can

row at 50°C. Anaerobic

Source · From intestinal contents, caseous gangrene, and from soil.

Habitat: Common in soil, especially here heavily manured.

The following species are commonly egarded as variants of the typical Rostridium sporogenes

13a. Clostridium sporogenes var. A. P. Marie Prévot, Ann Inst. Past., 61, 1938, 3 (Bacille anaérobie, Marie, Compt. end Soc. Biol., Paris, 95, 1925, 21).

Resembles the typical Clostridium appropriate except in the sharp but not putrid odor of its cultures.

Pathogenicity. Large abscesses are induced on subcutaneous injection into guinea pigs

From spontaneous putrefaction of macerated pork.

13b Clostridium sporogenes var. equine Prévot, Ann Inst. Past., 61, 1938, 83 (Unnamed anserobe No. IV, Choukévitch, Ann. Inst Past, 25, 1911, 259).

Sporulation is delayed and restricted. Spores are long and almost rectilinear. Litmus milk is coagulated, then the clot is digested after 3 to 4 weeks.

Congulated albumin is slowly dissolved.

Not pathogenic for guinea pig or mouse. From large intestine of horse.

13c. Clostridium tyrosinogenes (Hall) Bergey et al. (Culture No. 106, Hall and Finnerud, Proc. Soc. Expt. Biol and Med., 19, 1921-22, 48; Bacullus tyrosinogenes Hall, Abst. Bact., 6, 1922, 7; not Bacillus tyrosinogenes Rusconi, as cited by Carbone, Ramsrotti, Mazrucchi and Monti, Boll. Ist. Sieroter, Milan, 2, 1921, (267), see Clark and Smith, Jour. Bact., 37, 1939, 278; Bergey et al., Manual, 1st ed., 1923, 329; Clostridium sprogenes var. tyrosinogenes Prévot, Ann. Inst. Past., 61, 1938, 83.) From Greek, tyrus, cheese; M. L., tyrosinum, tyrosine; genes, producine.

Ferments monosaccharides but not higher carbohydrates (Hall, Jour. Inf. Dis., 50, 1922, 482).

Traces of gas, but no acid, from glycerol, sorbitol, mannose, xylose, lactose, sucrose, arabinose, galactose, salicin, inulin, detrin and starch (F. E. Clark,

inulin, dettrin and starch (F. E. Clark, personal communication). Distinctive character: Forms large amounts of tyrosin which precipitate in

cultures in protein media.

Source · Originally isolated from a culture erroneously labeled Bacillus tetani.

Later isolated from an amputated arm.

Habitat: Not determined. Only two isolations on record.

13d Clostridium föbeldirerum Sturges and Reddish. (Fish-tailed putrefactive anaerobe, Reddish and Sturges, Abst. Bact., 8, 1924, 5, Sturges and Reddish, Jour. Bact., 11, 1926, 37; Clostridium sporogenes var. caudapiscis Prévot, Ann. Inst. Taxt., 61, 1933, 83.) From Latin, fabellum, a little fan; Jer. bearing.

Glucose agar surface colonies (anacroble). Coarse, raised, with long peripheral intertwining outgrowths.

Deep plain agar colonies: Irregular, becoming woolly. Sucrose is fermented (in contrast with

Clostridium sporogenes).

Distinctive character: Spores are long

retained within the sporangium, of which the distal end frays out to fibrils, giving the characteristic fish-tail appearance. Otherwise closely resembles Clostridium sporogenes.

Source: From sourcd hams and from salt.

Habitat: Not determined, other than these sources.

13c. Clostridium parasporogenes (Bulloch et al.) Bergey et al. (Bacillus Type XII, McIntosh and Fildes, Med. Res. Counc., Spec. Rept. Ser. No. 12, 1917, 36; Bacillus parasporogenes Bulloch et al., Med. Res. Counc., Spec. Rept. Ser. No. 39, 1919, 39; Bergey et al., Manual, 1st ed., 1923, 327; Clostridium sporogenes var. parasporogenes Prévot, Ann. Inst. Past.. 61, 1938, 83.)

· Deep agar colonies: Lenticular to slightly irregular. Not woolly.

Pathogenic for young guinea pigs. Filtrate non-toxic on injection or on feeding.

Optimum temperature 30°C to 35°C. Distinctive character: Resembles Clostridium sporogenes, but does not form woolly colonies in deep agar, and is agglutinatively distinct Probably mercly a variety.

Source: From gaseous gangrene.

Habitat Not determined. Probably occurs in soil.

14. Clostridium parabotulinum Bengtson. (U. S. Pub. Health Serv., Hyg. Lab. Bull. 136, 1924, 32; Types A and B, Burke, Jour Bact , 4, 1919, 556, Clostridium botulinum Types A and B, Bergey et al., Manual, 1st ed , 1923, 328.) From Latin, para, like; M.L., botulinum, a species name.

Nore: This group comprises the putrefactive (ovolytic) species, including strains commonly referred to as Memphis and Canton (Type A), and Nevin (Type B). Growth of these types is more easily obtained than with the Clostridium botulinum strains, and the reactions are more obvious.

Gunnison and Meyer (Jour. Inf. Dis. 45, 1929, 139) propose an intermediate ~\*.... t i

a group would provisionally include certain European Type B strains, the Australian Type C, certain American Type C strains, and the South African Type D.

Rods: 0.5 to 0.8 by 3.0 by 80 microns, with rounded ends, occurring singly, in pairs, and in short chains. Motile with peritrichous flagella. Spores oral. subterminal, distinctly swelling rods. Gram-positive.

Gelatin: Liquefied.

Deep liver agar colonies: Type A tend to be restricted to compact disks, with sharp outline and small, opaque nucleus at periphery. Type B tend rather to form loose, woolly colonies (indicative only).

Liver agar surface growth (anaerobic). Profuse, moist.

Broth: Fairly abundant diffuse tur-Many strains spontaneously agglutinate.

Liver broth: Luxuriant turbidity. Profuse gas.

Milk: Slight acidity; slow curdling precipitation, with subsequent digestion and darkening.

Fermentation records are variable. Acid and gas from glucose, fructose, maltose, devtrin, glycerol and salicia-Galactose, sucrose, lactose, rhamnose, raffinose, inulin, adonitol, dulcitol, mannitel, xylose, arabinose and inesitel not fermented (Bengtson, loc. cit., 22-25).

Coagulated albumin liquefied: Action of Type B usually more marked than

that of Type A. Blood serum liquefied.

Brain medium blackened and digested, with putrefactive odor.

Meat medium blackened and digested. Putrefactive odor. Tyrosine crystals not observed.

Pathogenic for animals. Forms 8 powerful exotoxin which is neurotoxic both on injection and feeding, and which is neutralized only by the homologous type antitoxin.

Optimum temperature: Records at variance. Grows best at 35 to 37°C. Toxin production best at about 28°C.

Anaerobic.

Distinctive character: Types are identified chiefly by protection tests with known-type antitoxin, and to less extent by agglutination.

Source. Chiefly from spoiled, non-acid canned goods, from soil and from silage. Habitat: Found rather widely dis-

persed in soil.

15 Clostridium saccharolyticum Beregey et al (Bacillus sporogenes saccharolyticus Distaso, Cent. f. Bakt., I Abt., Orig., 68, 1911, 190, Bergey et al., Manual, 1st ed., 1923, 334) From Greek, saccharum, sugar, lyticus, dissolving, digesting.

Rods Short, rounded ends, occurring singly, in pairs and in short chains. Motile Spores large, oval, excentric to subterminal, swelling rods. Gram-positive

Gelatin . Liquefied.

Deep glucose agar colonies. Gray, biconvex, lenticular, granular, entire. Gas is formed

Broth: Turbid.

Milk Soft coagulation; easein precipitated, then peptonized, leaving a clear, vellow-amber supernatant fluid.

Indote is formed.

Acid and gas feebly formed from glucose. Lactose and sucrose feebly, or doubtfully, fermented.

Congulated albumin slowly liquefied.

Grows well at 37°C.

Anaerobic.

Distinctive character: All cultures give a mixed butyric and fecal odor.

Source. From feces of a chimpanzee Habitat: Not determined, other than this source

16 Clostridium regulare Bergey et al. (Bacillus sporogenes regularis Distaso, Cent. f. Bakt., I Abt., Orig., 59, 1911, 100; Bergey et al., Manual, 1st ed., 1923, 334.) From Latin, straight.

Long rods: With rounded ends, occurring singly and in pairs Motile. Spores oval, small, subterminal, slightly swelling rods Gram-positive.

Gelatin: Liquefied.

Deep agar colonies: Small, opaque, irregular.

Milk: Acid; slowly coagulated, then clot slowly digested.

Indole formed in small quantity.

Slight acidity from glucose, lactose and sucrose. Gas is not formed. Odor of scatol and valerianic acid.

Coagulated albumin slowly liquefied, Grows at 37°C.

Anaerobic.

Source. From buman feces.

Habitat: Not determined, other than this source

 Clostridium hastiforme MacLennan (A4, Cunningham, Cent. f. Bakt., II Abt., 82, 1930-31, 437, and B4a, Cunningham, ibid., 83, 1931, 11; MacLennan, Jour. Path. and Bact., 49, 1939, 543.)
 From Lattu, resembling aspear.

Rods: Slender, 0.3 to 0.6 by 2.0 to 6.0 microns, with rounded ends, occurring singly, in parts, and rarely in short chains. Filaments not observed. Motile, with delicate pertirchous fiagella, motility persists even after sporulation. Spores ellipsidal, subterminal, swelling rods. Polar-cap of protoplasm remains long attached to free spores. Gram-positive attached to free spores.

attached to free spores. Gram-positive Gelatin: Rapidly liquefied. Blackening not recorded.

Plain agar surface colonies (anaerobic): Minute translucent dots, becoming irregularly round, granular, grayish-white, with opaque center and delicate translucent border.

Blood agar surface colonies (anaerobic):
As above, but larger and more opaque.
Old colonies show grayish pigmentation.
No hemolysis.

Deep plain agar colonies: Small, irregularly round with coarsely filamentous border. A little gas is occasionally formed.

Broth: Transient uniform turbidity, quickly settling as a heavy, white, flocculent deposit. Culture assumes a cheesy odor.

Milk: Abundant growth, with labcoagulation in 2 to 3 days. No increase in acidity; becoming slightly alkaline. Clot completely digested in 10 to 14 days, leaving a white, semi-translucent fluid of cheesy odor.

Indole not formed.

Ammonia not formed.

Hydrogen sulfide not formed.

Glucose not fermented.

Carbohydrates not fermented.

Egg medium: No digestion or other visible change

Congulated albumin not digested or blackened.

Blood scrum not digested or blackened. Meat medium not digested or blackened, even in presence of metallic iron. Meat varticles slightly reddened.

Brain medium not digested blackened.

Grows well between 22°C and 37°C. Angembic

Non-pathogenic to guinea pigs on subcutaneous inoculation (Cunningham, Cent f Bakt., II Abt , 83, 1931, 12)

Source Originally isolated by Cunningham as a dissociant from a culture of Bacıllus saccharobulyrıcus von Klecki. Later isolated by MacLennan; I strain from a culture of Clostridium sporegenes, and 2 strains from street dust

Habitat, Not determined, other than these sources.

18 Clostridium subterminale (Hall and Whitehead) comb nov (Bacillus subterminalis Hall and Whitehead, Jour. Inf. Dis , 41, 1927, 66.) Named from the characteristic position of the spores.

Rods Occurring singly, in pairs and rarely in short chains Motile. Spores oval, subterminal, swelling rods. Grampositive

Gelatin: Slowly liquefied, with slight turbidity and black sediment.

Blood agar surface colonies (anaerobic): Delicate. At first mildly, later actively, hemolytic.

Deep agar colonies: Opaque, compact. biconvex or lobate discs.

Agar slant (anaerobic): No surface growth.

Glucose broth: Turbidity, but no soid or gas formed.

Indole not formed.

Milk: Slowly coagulated (2 to 3 days), with mild acidity and gas. Slow but complete digestion of casein (8 to 18 days).

Glucose, fructose, galactose, maltose and lactose not fermented.

Brain medium: Slight turbidity in supernatant fluid. Slight gas formation and slow digestion.

Iron brain medium: Blackened in 2 to 3 days.

Tyrosin crystals not observable

Non-pathogenic to guinea pigs on subcutaneous injection.

Grows well at 37°C.

Obligately anacrobic.

Source: From an African arrowhead. Habitat: Not determined, other than this source.

Clostridium malenominatum (Weinberg et al.) comb. nov. (Pseudo-coli anaérobie, Jungano, Compt. rend. Soc. Biol., Paris, 65, 1908-09, 457; Bacillus pseudo-coli anaérobie Jungano and Distaso, Les Anaérobies, 1910, 162; Bacillus useudocols anaerobsus LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914, 345; Bacillus malenominatus Weinberg et al., Les Microbes Anacrobies, 1937, 763; Paraplectrum malenominatum Prevot, Ann. Inst. Past., 61, 1938, 75) From Latin, meaning badly named.

Rods: Short, cocco-bacillary, becoming elongated to short filaments in old cultures-especially in sugar broth. Ends rounded. Distinct bipolar staining Capsulated, tendency. Non-motile. especially in body fluids. Spores oval, subterminal, slightly swelling rods, Gram-perative

Gelatin No growth

Deep agar colonies: Small, round, very regular, almost transparent. Gas not formed

Plain broth: Uniform turbidity, settling after 48 hours, forming a fine, powdery sediment

Indole not produced.

Milk Growth with no coagulation

Glucose and sucrose not fermented. Coagulated albumin Not attacked

Meat medium : Abundant growth No record of changes. Capsules are demonstrable in this medium.

Very pathogenic for guinea pigs, which die of septicemia in 24 hours after intraperitoneal inoculation. Less pathogenic for rabbit, which dies after one week.

Toxin not demonstrable in cultures Grows at 22°C to 37°C

Obligately anaerobic. Source From feces of a diarrheal

infant Habitat: Not determined, other than

this single isolation.

20 Clostridium bifermentans (Weinberg and Seguin) Bergey et al. (Bacillus bifermentans sporogenes Tissier and Martelly, Ann. Inst. Past , 16, 1902, 894; Racillus bifermantans Weinberg and Seguin, La Gangrène Gazeuse, Paris, 1918, 128: Martellillus bifermentans Heller. Jour Bact , 7, 1922, 8. Bergev et al , Manual, 1st ed , 1923, 323 ) From Latin, bis, twice, and fermentum, a ferment. Closely related if not identical species.

Bucillus centrosporogenes Hall, Jour Inf Dis , 30, 1922, 464 (Clostridium centrosporogenes Bergey et al., Manual, 1st ed , 1923, 322), Bacillus oedematis sporogenes Sordelli, Compt. rend Soc. Biol., Paris. 89, 1923, 55 (Anaérobie agent de gangrène gazeuse, Sordelli, ibid., 87, 1922, 838, Bacillus sordelli Hall and Scott, Jour Inf Dis , 41, 1927, 329, Bacillus aporogenes oedematis Piening, Thesis, Hanover, 1931, (?), cited from McCoy and McClung, The Anaer. Bact., etc , 2, 1939, 492. Clostridium sordelli Prévot, Ann.

Inst. Past 61 1938 83). Closterdrum aedematordes Meleney. Humphrays and Carp. Proc. Soc. Expt. Biol. and Med . 44 1096-97 677

Varying degrees of virulence and toxicity occur in the shove group. The more toxic and virulent strains are commonly referred to as Rucellus sordelle although otherwise an apparently homogeneously organized group

Probable synonyms: Clostridium foetidum Liborius, Ztschr f Hye. 1, 1886, 160 (Cornilia foctida Trevisan, I generi e le specie delle Batteriacee, 1889, 22, Bacillus foetidus Chester, Ann Rent, Del Col. Agr Exp. Sta., 10, 1898, 128; not Bacillus foetidus Trevisan, loc cit , 16). Bacellus Lauefaciens magnus Luderitz. Ztschr. f. Hyg., 5, 1889, 146 (Cornsha magna Trevisan, loc cit, 22: Bacillus mannus Herfeldt, Cent f Bakt, II Abt . 1. 1895, 78. Bacillus maonus lique faciens LeBlave and Guggenheim, Man. Prat d Diag Bact, Paris, 1914, 327. Racellus foetadus clostraduformas LeBlave and Guggenheim, idem, 327). Clostridium foetidum carnis Salus, Arch. f. Hyg., 51, 1904. 121 (Clostridium carnis foetidum and Clostridium foetidum Salus, abid . 121 and 124; Clostridium carnofoetidus McCrudden, Jour, Biol Chem. 8, 1910-109. Clostridium carnofoetidum Prévot, Ann Inst Past , 61, 1938, 84). Bacillus sporogenes var B. Metchnikoff. Ann. Inst. Past., 22, 1908, 944 (Clostridium sporogenes var. B. Prévot. Ann. Inst Past , 61, 1938, 83), Bacillus sporogenes foetidus Choukévitch, Ann Inst. Past , 25, 1911, 257 (Bacillus foetidus Choukévitch, ibid , 258), Bacillus putrificus tenuis Zeissler, Ztschr. f. Infkrnkh. u. Hyg Haust , 21, 1920-21, 13, Bacillus nonfermentans Hall and Whitehead. Jour. Inf. Dis., 41, 1927, 65

Rods 08 to 10 by 50 to 60 microns. occurring singly, in pairs, and in short chains. Spores oval, central to excentric. not distinctly swelling rods Motile in very young cultures only (less than 24 hours old) Gram-positive

Gelatin: Liquefied and blackened.

Agar surface colonies (anaerobie): Circular, crenated to amochoid.

Blood agar surface colonies (anaerobie): Small, transparent, hemolytic, becoming opaque, yellowish, spreading.

Broth: Turbidity and gas. Thick mu-

Litmus milk: Slowly congulated. Slowly peptonized, with little gas. Indole is formed.

Nitrites not produced from nitrates.
Hydrogen sulfide is produced.

Acid and gas from glucose, fructose, mannose and maltose. Lactose, sucrose and inulin not fermented. Records suggest variability in glycerol and salicin.

Coagulated albumin rapidly liquefied and blackened.

Blood serum liquefied and blackened. Brain medium digested and blackened.

Figs-meat medium digested and blackened. Tyrosin crystals in 8 to 10 days. Pathogenicity Variable with the strain; some kill rabbits in 21 hours; others produce only slight edems, while

some show no effect.

Toxicity . Likewise variable, from acute
to none

Optimum temperature from 30°C to 37°C. Can grow at 50°C.

Anaerobie,

Source. Originally from putrid meat; subsequently from gaseous gangrene.

Habitat: Occurs commonly in feces, soil and sewage. Widely distributed in nature.

21. Clostridium mucosum (Klein) Bergey et al. (Backu. I. Mtn. 29, 1901, 991; not Bacillus mucosus Xienn, Cent. I. Bakt., I. Abt., 29, 1901, 991; not Bacillus mucosus Zummermann, Die Bakt. unserer Trink- u. Nutzwasser, Chemitz, 2, 1891, 8, Bacterium mucosum Migula, Syst. d. Bakt., 2, 1900, 315; Bacillus İkeini Buchana and Hammer, Iowa Agrie Evp. Sta. Res. Bull. 22, 1915, 276; not Bacillus İkeini Migula, Syst. d. Bakt., 2, 1900, 766; not Bacillus İkeini Agrie Zentrosi and

Meinií

Bergey et al., Manual, 1st ed., 1923, 321; Bergey et al., Manual, 4th ed., 1931, 472; not Clostridium mucosum Eimola, cited from Prévot, Man. d. Class., etc., 1910, 112; Endosporus mucosus Prévot, Ann. Inst. Part., 61, 1933, 75.) From Latin, silmy.

Rods: 1.3 by 2.0 to 5.0 microns, occurring singly, In pairs and in chains. Motille. Spores oval, central, not seelling rods. Gram-negative (Klein, loc. cit.). Young cultures Gram-positive (Buchanan and Hammer, loc. cit.).

No growth in media without earbohy-drafes.

Glucose gelatin: Slowly liquefied.
Glucose gelatin surface colonies (anasrobic): Small, gray.

Glucose gelatin stab; Villous growth. Slow liquefaction.

Glucose agar slant (anaerobic): Thin, veil-like layer. Slimy condensation water.

Glucose broth: Turbid. Gas bubbles. Litmus milk: Acid; slowly coagulated, slimy. Gas formed. Odor of butyric acid.

Potato: No growth. Indole not formed.

Nitrites not produced from nitrates.

Acid and gas from glucose.

Rload serum : No growth.

Non-pathogenic.

Grows at 37°C.

Anaerobic.

Source: Blood sausage (Blutwurst).
Habitat: Not determined, other than
this source.

22. Clostridium pruchii (Buchanan and Hammer) Bergey et al. (Bacillus lactis pruchit Conn. Esten and Stocking, 18th Ann. Rept. Storrs Agric. Exp. Sta. 1906, 179) Bacillus pruchii Buchanan and Hammer, Iowa Agric. Exp. Sta. Res. Bull. No. 22, 1915, 276; Bergey et al., Manual, 1st ed., 1923, 322.) Named for M. J. Prucha, American bacteriologist.

Rods: Variable in size, with clubshaped ends. Motile, with peritrichous flagella. Spores central, oval, not swelling rods Gram-positive.

Gelatin Rapid, stratiform liquefaction. Reddish-yellow sediment.

Round, flat, white, smooth, opaque.
Agar slant (anaerobic). Luxuriant,

white, viscid.

Broth Turbid, with flocculent pellicle

and gray viscous sediment
Litmus milk · Acid; slowly coagulated,

becoming slimy yellow.

Potato, Thin, brownish, spreading

Indole not formed.
Nitrites not produced from nitrates

Acid but no gas from glucose. Congulated albumin not recorded.

Coagulated albumin not recorded Blood serum not liquefied

Non-pathogenic, Optimum temperature 30°C Grows well between 20°C and 37°C.

Anaerobic

Source. From slimy milk. Habitat: Not determined, other than this source.

23 Clostridium cylindrosporum Barker and Beek (Jour. Biol. Chem., 141, 1941, 3) Named from the characteristic spore morphology

Rods 10 by 4 0 to 7.0 microns, straight. Motile with peritrichous flagella Spores clongate to cylindrical, 10 to 1.1 by 1.7 to 30 microns, central, subterminal terminal, with little or no swelling of rods Gram-necative.

Iron-gelatin (Spray), No growth.

which gradually disappears.

Deep plain agar. No growth.
Deep uric acid agar colonies. Whitish,
compact, lobate, I to 2 mm in diameter,
with irregular edges, surrounded by a
zone of precipitated ammonium ureate

Plain broth: No growth, Glucose broth: No growth, Ifon-milk (Spray): No growth,

Iron-mik (Spray): No growth.

Indole not recorded (probably negative).

Nitrites not recorded (probably negative).

Glucose not fermented.

Carbohydrates not fermented Cellulose not fermented.

Coagulated albumin not liquefied. Blood serum not liquefied.

Brain medium not digested or blackened.

Pathogenicity not recorded (probably

Pathogenicity not recorded (probably non-pathogenic)
Ontimum temperature about 35°C.

Optimum resetion about pH 7.5; lower limit for growth pH 6.5.

Distinctive characters: Requires uric acid, or certain other purnes, as a primary source of carbon and energy. The purness are converted into ammonia, COs, acetue acid and a little glyene. This organism is physiologically similar to Clostridum cordi-uric, but may be readily distinguished from the latter by its morthology.

Source. A single strain isolated from

Habitat Probably soil, although only this single isolation is recorded.

24. Clostridium perfringens (Veillon and Zuber) Holland.\* Clostratum perfringens Type A, Witsdon (Bacillus aerogenes capsulatus Welch and Nuttall, Johns Hopkins Hosp. Bull 5, 1892, 81 (Bacillus capsulatus aerogenes Lehmann and Neumann, Bakt. Diag, 2 Aufl. 4, 1899, 327); Bacillus phlegmones emphysematosae Praenkel, Ueber Gasphleg.

<sup>\*</sup>Recause of use of the species name perfringers by the Permanent Standards Commission of the Health Organization of the League of Nations (Report of the Permanent Commission on Biological Standardization, London, June 23, 1931), the use of this name has been continued although it is preceded by a valid binomial (Bacillus emphysemolosus Kruse).

monen, Leipzig, 1893, 47; Bacillus emphysematosus Kruse, in Flügge, Die Mikroorg., 3 Aufl., 2, 1896, 242; Bacterium aerogenes capsulatus Chester. Ann. Rept. Del. Col. Agr. Exp. Sta., 9, 1897, 125; Bacterium emphysematosus Chester, ibid., 126; Bacillus emphysematis raginae Lindenthal, Wien. klin. Wehnschr., 10, 1897, 42; Bacillus perfringens Veillon and Zuber, Arch. Med. Expt. et Anat. Path., 10, 1898, 539; Bacillus cansulatus anaerobius and Bacillus capsulatus aerogenes Binaghi, Cent. f. Bakt., II Abt., 4, 1898, 920; Granulo-\*accharobutyricus immobilis liquefaciens Schattenfroh and Grassberger, Cent. f. Bakt., II Abt., 5, 1899, 702 (Granulobacillus immobilis Schattenfroh and Grassberger, Arch. f. Hyg , 37, 1900, 68, Bacillus amylobacter immobilis Gratz and Vas. Cent f. Bakt . II Abt .. 41, 1914, 509), Bacterium welchii Migula, ıbıd., 392; Bacıllus welchii Lehmann and Neumann, Bakt Diag , 4 Aufl., 2, 1907, 457; Bacillus butyricus asporogenes immobilis Rocchi, Cent f. Bakt., I Abt., Orig., 60, 1911, 580, probably Bacillus multiformis Distaso, Cent. f Bakt., I Abt , Orig , 69, 1911, 101 (Bacteroides multiformis Bergey et al , Manual, 1st ed., 1923, 263, Cillobacterium multiforme Prévot, Ann. Inst Past 60, 1938, 297; not Bacillus multiformis van Senus, Inaug. Diss., Leiden, 1890, (?), quoted from Herfeldt, Cent. I Bakt., II Abt, 1, 1895, 117); Bacillus aerogenes-capsulatus Holland, Jour Bact., 5, 1920, 217, Clostridium acrogenes-capsulatum Holland, ibid , 217, Bacillus phlegmonesemphysematosae Holland, ibid, 219; Clostridium phlegmones-emphysematosae Holland, ibid , 219; Clostridium phlegmones emphysematosae Holland, shid., 222; Clostridium welchir Holland, ibid., 221, Clostridium perfringens Holland, abid., 219; Welchillus aerogenes Heller, Jour. Bact., 7, 1922, 6; Butyribacillus immobilis-liquefaciens Heller, ibid., 18; Bacıllus welchir Type A Wilsdon, Univ. Cambridge, Inst. Animal Path., 2nd Rept. of Dir., 1931, 72, Clostridium

saccharobutyricum liquefaciens van Beynum and Pette, Cent. f. Bakt., II Abt., 93, 1035-36, 205; Welchia perfringens Prévot, Ann. Inst. Past., 61, 1938, 78.) Latinized, very fringed

Related varieties: Clostridium egens Bergey et al., Manual, 1st ed., 1923, 324 (Bacillus egens Stoddard, Jour Evp. Med., 29, 1919, 187; Stoddardillus egens Heller, Jour. Bact., 7, 1922, 6; Clostridium perfringens var. egens Haudumy et al. Dict. d. Bact. Path., 1937, 121; Welckia perfringens var. egens Prévot, Ann. Inst. Past., 61, 1938, 78).

rast., ot., 1038, 78).
Clostridium perfrangens Type B, Wisdon. (Bacillus of lamb dysentery, Dalling, Jour. Path. and Bact., 28, 1925, 536, and ibid., 29, 1926, 316; U. D. Bacillus, Dalling, Handbook Ann. Congr. Nat Vet. Med. Assoc., Gl. Dritain and Ineland, 1928, 56; Bacillus welchii Type B, Wisdon, Univ. Cambridge, Inst. Animal Path., 2nd Rept. of Dir., 1931, 73; Clostridium welchii (Type qqui) Glenny et al., Jour. Path. and Bact., 37, 1933, 53; Bacillus agni Weinberg et al., Les Mic. Anaér., 1937, 233; Welchia agni Frévet, Ann. Inst Pats., 61, 1938, 78.)

Clostridium perfringens Type C, Wisdon. (Bacillus paludis McEven, Jour. Compar. Path, and Ther. 43, 1930, 1; Bacillus welchit Type C, Wilsdon, Univ. Cambridge, Inst Animal Path. 2nd Rept of Dir. 1931, 73; Welchia ogni var. paludis Prévot, Ann Inst. Past. 81, 1983, 78; Welchia paludis Prévot, Man d. Class. etc., 1910, 217.)

Clostridum perfringena Type D, Wilsdon. (Bacillus welchit Type D, Wilsdon, Univ. Cambridge, Inst. Animal Path., 2nd Rept. of Dir., 1931, 74; Bacillus ovilozicus Bennetts, Austral. Inst. Sci. and Indus, Bull. No. 57, 1032, 5, and Vet. Jour., 88, 1932, 250; Welchia agni var cultoricus Perfovt, Ann Inst Past, 61,

## 217.)

Probably related (or possibly identical) varieties: Bacille du rhumatisme, Achalme, Comut. rend. Soc. Biol., Paris. 49 1801 651 and Ann Inst. Past. 11. 1897 848 (Bacille and bacterium d'Achalme, Thiroloix, Compt. rend Soc. Biol Paris, 49, 1897, 268, Bacillus achalmes Neveu-Lemaire, Précis Parasitol. Hum . 5th ed . 1921, 24); Bacillus emphysematis maliani Wicklein, Arch. f. Path Anat u Physiol 195 1801 01 Racillus codmerus Sternherg Researches relating to the etiology and prevention of vellow fever, Washington, 1891, 212 (Racterium cadareris Migula Syst. d. Bakt. 2, 1900, 510, not Bacillus cadaveris Klein, Cent. f. Bakt., I Abt., 25, 1899. 279 not Clostridium cadaveris Sternberg. loc cit. 213; not Bacillus cadaveris Migula, loc cit., 646); Bacillus cadaveris buturious Buday, Cent. f. Bakt., I Abt. 24. 1898. 374 (Bacillus budays and Bacterrum cadareris buturicum LeBlave and Guggenheim, Man, Prat de Diag Bact. 1914, 378, Eubacterium cadaveris Prévot. Ann Inst Past., 60, 1938, 295).

Bacillus zoodysenteriae Weinlierg et al, Les Mic. Anaér, 1937, 256 (Bacillus zoodysenteriae hungarieus Detre, Cent Bakt, I Abt., Orig., 104, 1927, 251, Welchia perfringens var. zoodysenteriae Prévot, Ann Inst. Past, 51, 1938, 759

Clostridium perfringens var. anaerogenes Hauduroy et al., Dict d. Bact. Path, 1937, 122 (Unnamed species of Grootten, Compt. rend Soc Biol, Paris, 100, 1929, 499).

Rods: Short, thick, 10 to 15 by 40 to 80 microns, occurring singly and in pairs, less frequently in short chains. Nonmotile Sporesoval, central to excentric, not swelling rods. Encapsulated Grammositive

Gelatin Liquefied and blackened
Agar surface colonies (anaerobic).

Circular, moist, slightly raised, opaque center, entire

Broth: Turbid; peptolytic. Clearing with viscid sediment.

Litmus milk Acid, coagulated. Clot torn with profuse gas formation, but not directed. Potato: Thin, grayish-white streak;

Indole not formed.

Nitrates produced from nitrates.

Acid and gas from glucose, fruetose, galactose, mannose, maltose, lactose, sucrose, xylose, trehalose, raffinose, starch, glycogen and inositol. Mannitol not fermented. Salicin rarely fermented. Action on inulin and glycerol variable.

Coagulated albumin not liquefied.

Blood serum not liquefied

Brain medium not blackened or digested.

Egg-meat: Profuse gas production in 8 hours. The meat is reddened and the hould becomes turbid. No digestion.

Pathogenic for guinea pig, pigeon and mouse. Produces an exotoxin for which an antitoxin can be prepared.

Optimum temperature 35°C to 37°C. Can grow at 50°C.

Anaerobic.

Distinctive characters. Stormy fermentation of milk, combined with nonmotility.

Source: Gaseous gangrene, feces, milk and soil.

Habitat: Widely distributed in feces, sewage and soil.

25 Clostridium sphenoides (Bulloch et al ) Bergey et al (Bacillus sphenoides Bulloch, Bulloch, Bulloch, Bulloch, Melloch, Grands, Henry, McIntosh, O'Brien, Robertson and Wolf, Med Res Coune, Spec Rept Ser. No. 39, 1919, 43, Douglassilus sphenoides Heller, Jour Bact 7, 1922, 5; Bergey et al , Manual, 1st ed., 1923, 331; Pictridium sphenoides Prévot, Ann. Inst. Past., 61, 1938, 88) From Greek, wedge-shaped.

Described from Bulloch et al , loc. cit, as amplified by Hall, Jour. Inf. Dis., \$0.1922.502.

Rods: Small, fusiform in vegetative state, occurring singly, in pairs and occasionally in short chains. Sporulating cells cuneate. Motile. Spores spherical, subterminal, becoming terminal on maturation, swelling rods. Gram-positive only in young cultures.

Gelatin : Not liquefied.

Agar surface colonies (anacrobic): Circular, or slightly irregular, entire.

Blood agar surface colonies (anaerobic): Minute dew-drops, becoming whitish, opaque. Blood is bemolyzed.

Deep agar colonies: Minute, opaque, smooth disks.

Broth: Turbid.

Litmus milk: Acid; slowly and softly congulated. Clot not digested.

Indole not formed (indole formed by Tholby strain, Stanley and Spray, Jour. Bact., 41, 1941, 256).

Nitrites produced from nitrates.

Acid and gas from glucose, galactose, maltose, lactose and salicin. Inulin, glycerol and dulcitol not fermented. Strains are apparently variable on mannitol, sucrose, dextrin and starch.

Congulated albumin not liquefied.

Blood serum not liquefied.

Brain medium not blackened or di-

gested. Non-pathogenic for guinea pig and

rabbit.
Optimum temperature not determined.

Anaerobic.

Grows well at 30°C to 37°C

Source. From gangrenous war wounds. Habitat: Not determined, other than this source

26. Clostridium innominatum Prévot. (Bacillus E, Adamson, Jour. Path. and Bact., 22, 1918-19, 391; Prévot, Ann Inst. Past., 61, 1938, 85) From Latin, remaining unnamed

Rods: Very small, thick, tapeting at one or both ends, occurring singly, paired, in chains and filaments. Involution forms abundant on glucose agar. Motile. Spores small, spherical, subterminal, swelling rods Gram-positive, quickly becoming Gram-negative.

Gelatin: Not liquefied.

Glucose agar surface colonies (anaerobic): Two forms are produced: 1) Circular, entire edge, opaque; 2) Diffuse, spreading, irregular and translucent.

Plain agar surface colonies (anaerobie): Small, circular, entire edge, whitishtranslucent, becoming opaque-yellowish with age.

Plain broth: Moderate turbidity, clearing by sedimentation in 3 to 4 days.

Glucose broth: More abundant turbidity and slight gas production.

Milk: Slowly acidified but not clotted. No further change.

Glucose, maltose, lactose and r annitol fermented with acid and gas.

Sucrose not fermented. Congulated albumin: Not digested or

blackened, Meat medium: Not digested or black-

ened.

Blood serum: Not digested or black-

ened.
Brain medium: Not digested or black-

ened. Non-pathogenie (Prévot, loc. cit.).

Grows well at 37°C.

Anaerobic.

Source: From septic and gangrenous war nounds.

Habitat: Not determined, other than this source.

27. Clostridium filiforme Bergey et al. (Bacillus regularis filiformis Debooo, Cent. f. Bakt., I Abt., Orig., 62, 1912, 234; Bergey et al., Manual, 1st ed., 1923, 331.) From Latin, thread-like.

Rods: 0 5 to 0.8 by 3.0 to 5.0 micrors, slender, occurring singly, in pairs, in chains and filaments. Non-motile. Spores very small, spherical, subterminal, or occasionally terminal, not swelling rods. Gram-positive.

Gelatin : Not liquefied.

Deep gelatin colonies: Small, gray, filamentous.

Deep agar colonies: Irregular, gray, translucent, filamentous

Broth: Uniform turbidity.

Litmus milk. Acid, but no further chance.

Potato - Gray, filamentous: substance not digested.

Acid and gas from glucose and lactace Acid only from sucrose and dulcital. Starch not fermented.

Congulated albumin not liquefied Grows in celatin at 22°C.

Angembie.

Source: From human feces. Habitat. Not determined, other than this course

28 Clostridium sartagoformum Partansky and Henry, (Jour. Bact., 59, 1935. 570.) From Latin, shaped like a frymg-nan.

Rode 03 to 05 by 35 to 60 microns Slender, curved, with rounded ends, occurring singly Motile. Spores oval, terminal anelling rods. Gram-positive.

Gelatin · Not liquefied.

Agar surface colonies (anaerobic) Convex, discrete, circular, transparent to white and opaque. Surface moist and emonth.

Blood agar not hemolyzed.

Deep agar colonies · Regular, lenticular, smooth

Broth · Clear: no growth.

Glucose broth: Turbid, with gas bub-

Litmus milk. Acid: slowly coagulated. with some gas formation. Clot not dirested

Potato: Very scant growth No gas in surrounding liquid.

Indole not formed.

Nitrates not produced from nitrates. Acid and gas from xylose, glucose, fructose, galactose, sucrose, lactose, maltose, raffinose, inulin, salicin, mannitol, acetate and butyrate Starch, ethanol, glyc-

ero) and dulcated not fermented. Coagulated albumin not liquefied. Blood serum not liquefied, Scant

growth. Brain medium not blackened or digested Some gas is formed.

Ontimum temperature 37°C Anserobic.

Distinctive character: Ferments sulfite

waste liquor in 40 per cent concentration. forming butyric and acetic acids, II. and CO.

Source: From earden soil and from stream and lake mud.

Habitat . Not recorded . obviously soil Distribution undetermined

29. Clostrldium paraputrificum (Bien-

stock) Snyder (Art V. Rienstock, Fortschr. d. Med., 1, 1883, 612: Bacillus dianthirus Trevisan. I generi e le specie delle Batteriacee, 1889, 15; Bacıllus paranutrations Bienstock, Ann. Inst. Past. 20, 1906, 413, and Strassburger Med. Zeit. 5. 1906. 111: Bacillus paraputrificus coli Henry, Brit, Med. Jour. 1, 1917, 763; Tassierillus paraputrificus Heller, Jour. Bact., 7, 1922, 27; Snyder, Jour, Bact., \$2, 1936, 401: Plectridium paranutrificum Prévot, Man. d. Class., etc., 1940, 160.)

From Latin, also nutrefying,

Probable synonyms: Kopichenbakterien, Escherich, Fortschr. d. Med . 8. 1885, 515, Bacillus No. 3, Rodella, Ztschr. f Hyg., \$9, 1902, 209 (Plectridium fluxum Prévot, Ann. Inst. Past., 61, 1938, 87); Art XI, Hibler, Cent. f. Bakt., I Abt., 25, 1809, 516 (Art IX, Hibler, Untersuch, ū. d Path Anaer., 1908, 3 and 407: Plectridium nonum Prévot, Ann. Inst. Past., 61, 1938, 88); Anacrobe b. Dalvell. Jour Path, and Bact., 19, 1914-15, 281: Bacillus annutratus Kleinschmidt, Monatschr. f. Kinderheilkunde, 62, 1934, 18 (Palmula innutrita Prévot, Ann. Inst. Past., 61, 1938, 89: Acuformis innulvitue Prévot, Man d Class, etc., 1940, 165)

Described from Hall and Snyder, Jour.

Bact., 28, 1934, 181

Rods, 03 to 05 by 20 to 60 microns. Straight or slightly curved, single, in pairs, or in short chains. Ends rounded. Motile with peritrichous flagella. Spores oval, terminal, swelling rods, Grampositive.

Gelatin : Not liquefied. Gas is formed. Blood agar surface colonies (anaerobic): Delicate, irregular, round-topped dewdrops. Non-hemolytic.

Deep agar colonies: Small, irregular, opaque, dense, cottony masses. Gas is formed.

Broth : Diffuse turbidity.

Milk: Usually coagulated in from 6 to 10 days. Abundant gas, but no peptoniration

Indole is not formed.

Acid and gas from glucose, fructose, 11 -- 1--1--- ------ noffi

gested. Non-proteolytic.

Non-pathogenic for guinea pig and rabbit.

1 - 4 framental

Grove well at 37°C.

Anaerobie.

Source · Feces, gascous gangrene, and postmortem fluid and tissue cultures.

Habitat: Undetermined, other than these sources. Evidently occurs commonly in intestinal canal of human beings.

30. Clostridium cochlearium (Bulloch Danillus Type IIIc, sec. Rept.

ochlearius

Bulloch, Bulloch, Douglas, Henry, McIntosh, O'Brien, Robertson and Wolf, Med. Res. Counc , Spec. Rept. Ser No 39, 1919, - " -- " - anahlagrana Heller, Jour.

ium Prévot, Ann. Inst Past, 61, 1938, 88; Plectridium incertum Prévot, idem.) From Latin, spoon-shaped.

Rods: Slender, straight, occurring chiefly singly, or infrequently in pairs and in short chains. Motile with peritrichous flagella. Spores oval, terminal, swelling rods. Weakly Gram-positive.

Gelatin . Not liquefied.

Agar surface colonies (anaerobic). Circular, clear, entire, or with crenated

Deep agar colonies. Lenticular, entire Broth : Turbid.

Litmus milk: Unchanged. Glucose not fermented.

Carbohydrates not fermented. Coagulated albumin not liquefied.

Blood serum not liquefied. Brain medium not blackened or di-

rested. Meat medium: Slightly reddened. Not blackened or digested. Little gas of non-

nutrefactive odor. Non-pathogenic.

Optimum temperature 30°C to 35°C. Anaembie.

Source: From human war wounds and septic infections.

Habitat: Not determined, other than these sources. Probably occurs in soil,

31. Clostridium kluvveri Barker and Taha. (Jour. Bact., 48, 1942, 347.) Named for A. J. Kluyver, in whose laboratory the organism was discovered.

Rods: 0 9 to 1.1 by 3.0 to 11.0 microns. Straight to slightly curved; usually single, but also paired and occasionally in long chains. Motile with peritrichous flagella. Spores oval, terminal, swelling rods. Generally Gram-negative; some strains weakly Gram-positive when young.

Iron-gelatin (Spray): No growth.

Surface agar colonies (anaerobic): Growth slow and restricted by residual traces of oxygen. Rough and smooth colonies are produced.

Deep agar colonies (yeast autolysate and CaHaOH): Small colonies (1 to 3 mm) after 2 to 3 days; two types are formed: a) fluffy spheres with dense nuclear center and filamentous periphery; b) compact, lenticular colonies. Little eas is formed.

Plain broth: No growth.

Glucose broth : No growth. Milk or iron-milk (Spray): No growth.

Indole not recorded (probably negative).

Nitrites not recorded (probably negative).

Glucose not fermented.

Carbohydrates not fermented.

Cellulose not fermented.

Blood serum not liquefied.

Brain medium not digested or black-

Probably non-pathogenic.

Optimum temperature about 34°C. Grows between 19°C and 37°C.

Optimum reaction about pH 68. Range for growth pH 60 to 7.5.

Anaerobic.

Distinctive characters: Large size of cells, and slow growth, accompanied by non-putrefactive odor of caproic acid and of higher alcohols. Growth is exceptionally favored by synengestic association with Methanobacterium omelianskii. In pure culture a high concentration of yeast autolysate is required. Caproic acid is formed from ethyl alcohol.

Source. From black mud of fresh water

and marine origin

Habitat: Not determined, other than these sources. Evidently widely dispersed in nature

32. Clostridium acidiurici (Liebert) Barker. (Bacillus acidi urici Liebert, Koninkl Akad. v Wetensch., Proc. Sect. Sci., Amsterdam, 12, 1909, 55; Barker, Jour Bact. 38, 1933, 323.) Named from its characteristic ability to forment ure acid.

Rods: 0 5 to 0 7 by 2 5 to 4 0 microns, straight Motile with peritrichous flagella Spores oval, terminal, swelling rods. Most strains Gram-negative. A few strains weakly Gram-positive, quickly becoming Gram-negative.

Iron-gelatin (Spray): No growth.

Deep plain agar : No growth.

Deep uric acid agar colonies. Whitish, compact, lobate, I to 2 mm in diameter, with irregular edge, surrounded by a temporary zone of precipitated ammonum ureate which gradually disappears.

Surface uric acid agar colonies (anaerobic): Variable with strain and with moisture of medium. Colonies 1 to 2 mm in diameter, opaque, white, raised, round, smooth edge, with concentric surface markings, and of rubbery consistency. Other colonies may be very thin, soft, transparent, with fimbriate projections, spreading to cover almost the entire plate. Intermediate colony types also observed.

Plain broth: No growth.
Glucose broth: No growth
Iron-milk (Spray): No growth.
Indole not recorded (probably negative)

Nitrites not recorded (probably nega-

Glucose not fermented.
Carbohydrates not fermented.
Cellulose not fermented.
Coagulated albumin not liquefied
Blood serum not liquefied.

Brain medium not digested or blackened

Probably non-pathogenic.
Optimum temperature about 35°C.
Optimum reaction about pH 7.5; lower
limit for growth about pH 6 5.

Anaerobic.

Distinctive characters: Requires uric acid, or certain other purines, as a primary source of carbon and energy. The purines are converted mainly into ammonia, CO<sub>2</sub> and acetic acid. During growth the medium tends to become alkaline (pH 8 0 to 8 5); there is no visible evolution of eas

Source From soils of diverse origin Habitat. Evidently widely dispersed in soils Present in fecal material of yellow-shafted flicker (Colaptes auratus).

33 Clostridium capitovale (Snyder and Hall) Snyder (Bacillus capitoralis Snyder and Hall, Cent f. Bakt., I Abt., Orig, 155, 1935, 290, Clostridium capitoralis Snyder, Jour. Bact., 52, 1936, 401; Pletridium capitoralis Prévot, Ann. Inst. Past., 61, 1933, 87.) From Latin, oval-headed.

Rods. 0 5 to 0 8 by 2 0 to 2 5 microns. Slender, commonly curved, with rounded ends, occurring singly, in pairs, and rarely in short chains. Motile with long peritrichous flagella. Spores oval, terminal, an elling rods. Gram-positive.

Gelatin: Liquefied.

Blood agar surface colonies (anaerobic): Tiny, transparent, round or irregular dew-drops, becoming opaque. Non-hemolytic,

Deep agar colonies: Small, opaque, lenticular to heart-shaped.

Tryptone broth: Turbid. Gas is formed.

Milk:Often, but not invariably, clotted. Acid is formed. Clot, when formed, is not digested.

Indole not formed.

Nitrites not produced from nitrates.

Acid and gas from glucose, fructose and galactose. Maltose, lactose, sucrose, raffinose, xylose, inulin, dextria, starch, cellulose, amygdalin, salicin, mannitol and glycerol not fermented.

Coagulated albumin liquefied.

Blood scrum slowly softened and partially liquefied Not blackened. Mildly proteolytic.

Brain medium is blackened; slightly softened, but not conspicuously liquefied.

Pathogenicity Gunea pig may show slight subcutaneous edema; usually no effect. Non-pathogenic for rabbit.

Grows at 37°C.

Anaerobic.

Source Human feces, gaseous gangrene and septicemia.

Habitat: Not determined, other than these sources.

34. Clostridium parabifermentans comb. nov. (Bacillus parabifermentans Soc.

freek,

fermentum, a ferment.

Rods: 0 5 to 0.7 by 4.0 to 50 microns, occurring singly, in pairs and in chains of 3 to 5 cells. Motile. Spores oval, terminal, swelling rods Gram-positive.

Glucose gelatin. Rapid growth with liquefaction.

Deep glucose agar colonies: Lentícular, regular, opaque, whitish. Agar dis-

rupted by considerable gas of putrefactive odor.

Glucose broth: Abundant growth with uniform turbidity and with viscous sediment.

Milk: Acidified but not coagulated. Casein slowly precipitated with slow, but

Indole formed in trace.

Glucose, lactose and sucrose fermented to acids. (Gas not recorded.) Starch is not fermented.

Congulated albumin actively liquefied. Non-pathogenic for mouse.

Grows between 22°C and 37°C.

Source: From putrefying game (pheasant and guinea-fowl).

Habitat: Undetermined, other than this source.

35. Clostridium ovalare Bergey et al. (Bacillus putrificus ovalaris Deboto, Cent. f. Bakt., I Abt., Orig., 62, 1012, 231; Bergey et al., Manual, Ist ed., 1923, 336; Picctridium ovalaris Prévot, Ann. Inst. Past., 61, 1938, 88.) From Latin, oval.

Rods: 0 3 to 0.4 by 6.0 to 8 0 microns, straight or curving, ends rounded, occurring singly, in pairs and in short chains. Motile. Spores oval, terminal, swelling rods. Gram-positive.

Gelatin: Rapidly liquefied.

Deep glucose agar colvies: Small, globular, entire, becoming brownish Scant gas is formed.

Broth: Turbid.

Litmus milk: Acid, peptonized without

Indole not formed.

Acid and scant gas from glucose and lactose. Acid only from sucrose. Dulcitol not fermented.

Congulated albumin rendered transparent, then slouly peptonized, with a putrefactive odor.

Grows at 22°C and at 37°C.

Anserobic.

Source: Originally from putrid meat, later from feces.

Habitat: Not determined, other than these sources.

36. Clostridium zoogleicum Bergey et al. (Bacillus approgenes zoogleicus Distaso, Cent. f. Bakt., I Abt , Orig , 59, 1911, 99. Bergey et al., Manual, 1st ed . 1923, 335 ) From Greek, zoogleal

Rods: Pairly long, occurring singly, in pairs and in short chains Motile. Spores large, oval, terminal, swelling rods Gram-positive

Gelatin · Growth and liquefaction not recorded.

Deep agar colonies. Small, gray, slightly opaque, becoming heart-shaped Gas is not formed

Broth: Turbid, then clearing with zoogleal sediment.

Litmus milk. Slowly coagulated, then digested. Litmus reduced.

Indole is formed in trace.

Acid but no gas from glucose Lactose and sucrose not fermented

Coagulated albumin liquefied, leaving a clear fluid and zoogleal sediment Grows at 37°C.

Anserobic.

Source: From human feces.

Habitat: Undetermined, other than this source.

37. Clostridium thermosaccharolyticum McClung, (Jour. Bact., 29, 1935, 200; Terminosporus thermosaccharolyticus Prévot, Ann. Inst. Past. 61, 1938, 86 ) From Greek, heat, and sugar-digesting.

Rods 0.4 to 0 7 by 3 5 to 7.5 microns, slender, granulated, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores spherical, terminal, swelling rods. Gram-negative.

Gelatin . Not liquefied. Pea-infusion agar surface colonics

(anaerobic): Granular, grayish-white, raised center, with feathery edges

Deep glucose-tryptone agar colonies Small, lenticular, smooth Liver-infusion broth over liver meat

Turbidity and gas.

Litmus milk: Litmus reduced. Acid

and slow but firm congulation; congulum split with gas. Clot not digested

Indole not formed.

Nitrites not produced from nitrates. Cellulose not fermented.

Acid and gas from arabinose, fructose. galactose, glucose, mannose, vylose, cellobiose, lactose, maltose, sucrose, trehalose, dextrin, glycogen, corn-starch, amygdalin, esculin, a-methyl glucoside and salicin. Raffinose weakly fermented. Rhamnose, inulin, pectin, erythritol, mositol, mannitol, glycerol, querestol and Ca-lactate not fermented.

Coagulated albumin not liquefied.

Blood serum not liquefied

Brain medium not blackened or dicested

Meat-medium not blackened or digested.

Non-pathogenic on feeding to white rat, or by injection into rabbit

Optimum temperature 55°C to 62°C. Thermophilic.

Anaerobic.

Source: From hard-swell of canned goods, and from soil Habitat Not determined, other than

these sources

38 Clostridium caloritolerans Meyer and Lang. (Jour Inf Dis , 39, 1926, 321; Pleciridium caloritolerans Prévot, Ann. Inst Past., 61, 1938, 87.) From Latin, heat-enduring.

Rods · 0 5 to 0.8 by 8 0 to 10 0 microns. with rounded ends, occurring singly, in nairs, in chains and in curved filaments, Motile with peritrichous flagella Spores spherical or pear-shaped, terminal, swelling rods Gram-positive.

Gelatin : Not houefied.

Glucose blood agar surface colonies (anaerobic): Small, flat, grayish, Phizoidal. Non-hemolytic

Deep liver agar colonies; Small, flat, transparent disks with large polar tufts. Some colonies become fluffy

Broth: Slight turbidity.

Glucose broth: Abundant turbidity.

with clearing by sedimentation. Gas is formed.

Brom cresol purple milk: No change. Indole not formed

Acid and gas from glucose, galactose and maltose. Fructose feebly fermented. Lactose, sucrose, raffinose, inulin, salicin, mannitol, inositol and glycerol not fermented.

Cosgulated albumin not liquefied.

Blood serum not liquefied.

Brain medium not blackened or digested.

Beef-heart mash medium: Reddened; not blackened or divested.

Non-pathogenic for mouse, guinea pig and rabbit.

Optimum temperature not determined. Grows at 37°C. Anaerobic.

Source · From an old culture of Clostridium parabotulinum Type A

Habitat Not determined, other than this single isolation

39 Clostridium tetanoides (Adamson) Hauduroy et al. (Unnamed anaerobe, Adamson and Cutler, Lancet, J., 1917, 685; Bacillus ictonoides (A) Adamson, Jour. Path. and Bact. £2, 1918-19, 382; Hauduroy et al., Diet d Bact. Path. 1937, 140; Palmula macrospora Prévot, Ann. Inst. Past., 61, 1938, 88, Acuforms macrosporus Prévot, Man. d. Class, etc., 1940, 166) From Latin, tetanus-like.

Rods 10 to 20 by 40 to 120 microns (averaging 10 to 15 by 60 to 70 microns), with rounded to slightly tapered ends, occurring singly, in pairs and in chains of 3 to 5 cells, but not in filaments. Motile only in young cultures Spores large, spherical, terminal, swelling rods. Gram-positive in young cultures, soon becoming Gram-negative.

Gelatin Not liquefied.

Glucose agar surface colonies (anaerobic): Circular, regular, opaque, bluishgray, moist, shuning, thick, raised. Surface flat, becoming conical in center with age On moist medium showing radiating, dendritic branching. Growth becomes tenacious-mucoid

Plain agar surface colonies (anaerobic): Confluent, becoming an opaque film. Isolated colonies circular to slightly irregular. Dendritic branching and mucoid tendency less evident than on glucose agar.

Glucose agar stab: Thick growth along stab, starting 0.5 cm below surface. No gas or splitting of medium.

Neutral-red glucose agar: Reduced to orange by transmitted, and greenishfluorescent by reflected light.

Plain broth: Early slight turbidity, with clearing and mucoid sedimentation.

Glucose broth: Abundant turbidity and profuse mucoid sediment.

Milk: Slight and slowly increasing alkalinity, with slow separation of casein No further change.

Indole: Trace formed in broth.

Glucose and maltose fermented with acid but no gas. Lactose, sucrose, mannitol, starch and cellulose not fermented.

Congulated albumin: Not digested or blackened. Meat medium: Not digested or black-

ened.

Blood serum: Not digested or black-

ened.

Brain medium: Not digested or blackened.

Non-pathogenic for guinea pig and rabbit.

Optimum temperature not recorded Grows well at 37°C.

Anaerobic.

Source: From war wounds, from postmortem blood culture, and from garden soil.

Habitat: Not determined, other than these sources.

40. Clostridium tetani (Fingge) Holland. (Tetanusbacillen and Tetanuser-

nicolaieri Trevisan, I generi e le specii delle Batteriacee, 1889, 23; Plectridium tetani Fischer, Jahrb. f. Wissensch. Botanik, 27, 1895, (147?); Holland, Jour. Bact., 6, 1920, 220; Nicollaierillus tetani Heller, Jour. Bact., 7, 1922, 7.) From tetanus, lockjaw.

Rods: 0 4 to 0 6 by 4 0 to 8 0 microns, rounded ends, occurring singly, in paires, and often in long chains and filaments Motile with peritrichous flagella. Spores spherical, terminal, swelling rods Gram-positive.

Gelatin, Slowly liquefied and blackened.

Serum agar surface colonies (anaerobic): Small, transparent, villous to fimbriate margin.

Blood agar is hemolyzed.

Deep agar colonies: Fluffy, cottony spheres, usually without visible central nucleus.

Broth: Slightly turbid. Gas is formed Some strains clear quickly by sedimentation

Litmus milk: Slow precipitation of casein, or soft clotting Clot slowly softened, but not definitely digested. Little gas is formed.

Indole is formed

Nitrates not produced from natrates.

Glucose not fermented Carbohydrates not fermented.

Coagulated albumin slowly liquefied

Blood serum slowly softened, with feeble digestion.

Brain medium blackened and slowly digested. Not actively proteolytic

Pathogenic and toxic. Forms a potent evotoxin for which an antitoxin is prepared. Toxin intensely toxic on injection but not on feeding

Optimum temperature 37°C.

Anaerobic.

Source: Originally isolated from animals inoculated with garden soil extract Frequently isolated from wounds in human tetanus.

Habitat: Common in soils, and in human and horse intestine and feces.

41. Clostridium lentoputrescens Hartsell and Rettger. (Bacillus der Eiweissfaulniss, Bienstock, Fortschr. d. Med , 1, 1883, 614 (Art IV, Bienstock, ibid, 612; Eiweissbacillus, Bienstock, Ztschr. f klin Med., 8, 1884, 38). Bacıllus albuminis Schroeter, in Cohn's Kryptogamen-Flora von Schlesien, 3, 1, 1886, 162, Bacıllus putrificus coli Flügge, Die Mikroorg., 2 Aufl , 1886, 303; Pacinia putrifica Trevisan, I generi e le specie delle Batteriacec, 1889, 23; Bacillus putrificus Bienstock, Ann. Inst. Past. 13, 1899, 861; Bacillus butyricus putrefactens Rodella, Ann Inst. Past., 19 1905. 804: Putribacillus vulgaris Orla-Jensen, Cent. f Bakt, II Abt., 22, 1909. 343: Clostridium putrificum Holland, Jour Bact., 5, 1920, 220; Putrificus bienstocki Heller, Jour Bact., 7, 1922. 8. Bacillus putrificus (coli) Lehmann and Neumann, Bakt Diag , 7 Aufl , 2, 1927. 661: Hartsell and Rettger, Jour Bact . 27, 1934, 39 and 497; Plectridium putrificum and Plectridium putrificum var, lentoputrescens Prévot, Ann Inst Past, 61, 1938, 88 ) From Latin, slowly made nutrid.

Probable synonyms Bacillus radiatus Lideritz, Ztschr f. Hyg., 5, 1889, 149 (Corntha radiata Trevisan, loc. cit. 22; Bacillus radiatus anaerobius Hopffe, Ztschr f Infkrnkh u. Hyg Haust , 14, 1913, 392); Barillus cadateris sporogenes (anaerobicus) Klein, Cont f. Bakt, I Abt , 25, 1899, 279 (Bacillus cadateris Klein, idem; not Bacillus cadaveris Sternberg, Researches relating to the etiology and prevention of yellow fever, Washington, 1891, 212; not Bacillus cadaveris Migula, Syst d Bakt , 2, 1900, 646; Bacillus cadateris sporogenes Klein, loc. est., 284; Plectridium cadaveris Prévot. Ann. Inst Past , 61, 1938, 88); Art XIV, von Hibler, Untersuch. u. d Path Anger, 1908, 3 and 413; Bacillus tetanordes (B) Adamson, Jour. Bact. and Path , 22, 1918-19, 388

Hartsell and Rettger, loc cit., conclude that their organism differs very materially either from Clostridium cochlearium or from Bacillus putrificus, as described by Cunningham, Jour. Bact., 24, 1932, 61, and, as it cannot be definitely related to any other anaerobic species (including the Eiweisbacillus, Bienstock, loc. cit., Bacillus putrificus colifugge, loc. cit., Bacillus putrificus Bienstock, loc. cit., etc.), they propose the name of Clostridium lentoputrescens for this species.

Rods: 0.4 to 0.6 by 7.0 to 9.0 microns, with rounded ends, occurring singly, in pairs and in chains. Motile with peritrichous flagella. Spores spherical, terminal, swelling rods. Weakly Grampositive, becoming Gram-negative.

Gelatin: Liquefied.

Agar surface colonies (anaerobic): Small, circular, flat, edge created to filamentous spreading. Develop a ground-class appearance.

ground-glass appearance.

Deep agar colonies: Fluffy spheres with fibrils radiating from a central nucleus.

Blood agar is hemolyzed

Litmus milk: Slow, soft coagulation or flocculent precipitation. Casein is showly directed.

Indole is formed (Hall, Jour. Inf. Dis., 50, 1922, 141). Not formed (Hartsell and Rettger, loc. cit., 509).

Nitrites not produced from nitrates.

Hydrogen sulfide formed in egg-meat medium.

Carbohydrates not fermented. Glucose slightly attacked without distinct acid (Hartsell and Rettger, loc. cit., 508).

acid (Hartsell and Rettger, loc. cit., 508).
Coagulated albumin slowly liquefied and blackened.

Blood serum is liquefied. Gas is

formed.

Brain medium slowly blackened and

digested.

Egg-meat medium: Slightly turbid liquid. Meat reddened in 7 to 10 days, then digested with a foul odor.

Non-pathogenic for white mouse, guinea pig and rabbit Filtrate non-toxic on injection or feeding

Grows well at 37°C.

Anacrobic.

Source: From putrefying meat.

Habitat: Intestinal canal of human. Widely dispersed in soil. 42. Clostridium filamentosum Bergey et al. (Bacillus putrificus filamentosus Distaso, Cent. f. Bakt., I Abt., Orig., 59, 1911, 98; Bergey et al., Manual, 1st. ed., 1923, 333; Padinula filamentosa Frévot, Ann. Inst. Past., 61, 1938, 83; Acuformis filamentosus Prévot, Man. d. Class., etc., 1940, 165.) From Latin, filamentosus 1940, 165.) From Latin, filamentosus

Rods: Slender, occurring singly, in pairs and in chains. Motile. Spores spherical, or nearly so, terminal, swelling rods. Gram-positive.

Gelatia: Liquefied.

Deep glucose agar colonies: Delicate, cottony flocculi. Only a trace of gas formed.

Broth: Turbid.

Litmus milk: May or may not coagulate and digest slowly (variable).

Indole formed in scarcely detectable trace. Odor of scatol.

Glucose is feebly fermented, with little gas Lactose and sucrose not fermented. Congulated albumin: Rendered trans-

parent, then slowly liquefied.

Annembic.

Source: From human feces.

Habitat: Not determined, other than this source.

43. Clostridium tetanomorphum (Bulloch et al.) Bergey et al. (Bacillus pseudo-tetanus, Type No. IX., Tetanuslike Bacillus (Pesudotetanus Bacillus), McIntosh and Fildes, Med Res. Counc., Spec. Rept. Ser. No. 12, 1917, 11 and 32, Bacillus (clanomorphus Bulloch et al., Med. Res. Counc. Spec. Rept. Ser. No. 39, 1919, 41; Macintoshillus tetanomorphus Heller, Jour. Bact., 7, 1922, 5; Bergey et al., Manual, 1st et d., 1923, 330, Plectridium tetanomorphum Prévol, Ann. Inst. Past., 61, 1933, 87.) From Greek, shaped like the tetanus organism.

Synonyms or possibly related species: Bactilus pseudotetani Migula, Syst. d. Bakt., \$, 1900, 598 (Tetanushhnlicher Bactilus Tavel d.

Schweiz, 1, 2000, 1, teli

Chester, Man. Determ. Bact., 1901, 304; Pledridium pseudolelanicum Prévot, Ann. Inst. Past, 61, 1038, 87; Plectridium pseudo-telanicum Prévot, Man. d. Class., etc., 1910, 185); possibly identical with Bacillus fragilis Veillon and Zuber, Arch. d. Méd. Expt. et d'Anat. Path., 10, 1898, 536 and Bacillus ramosus Veillon and Zuber, third., 537.

Rods: Stender, with rounded ends, occurring singly and in pairs, not in chains. Motile with peritrichous flagella. Spores spherical, or nearly so, terminal, swelling

rods. Gram-positive.

Gelatin: Not liquefied, Gelatin is liquefied (Hall, Jour. Inf. Dis., 50, 1922, 501).

Agar surface colonies (anaerobic) Small, flat, irregularly circular, translucent, crenated.

Deep agar colonies: Small, opaque, irregular: not woolly or branched

Agar slant (anaerobic): Grayish, trans-

lucent growth, Broth: Turbid.

fermented.

Litmus milk: Unchanged; or occasional

slight reduction of litmus.

Acid and gas from glucose and maltose
Fructose, galactose, lactose, sucrose, salucin, inulia, mannitol and glycerol not

Coagulated albumin not liquefied.

Blood scrum not liquefied.

Brain medium not blackened or digested.

Egg-meat medium; Slight gas formation in 48 hours. White crystals are deposnted.

Non-pathogenic for guines pig and tabbit.

Grows at 30°C and 37°C.

Anaerobie.

Source: From war wounds and from

Habitat: Not determined other than these sources Probably rather common in soil.

44. Clostridium alcaligenes Bergey et al. (Bacillus anaērobicus alcaligenes Debono, Cent. f. Bakt., I Abt., Orig, 62, 1912, 232; Bergey et al., Manual, 1st ed., 1923, 331; Palmula alcaligenes Prévot, Ann. Inst. Past., 61, 1938, 89; Acuforms alcaligenes Prévot, Man. d. Class., etc., 1940, 165.) From French alcali, alkali and Latin suffix, producine.

Rods Long, slender, occurring singly, in pairs and in short chains. Non motile Spores spherical, terminal, swelling rods. Gram-positive

Gelatin . Not liquefied.

Deep glucose agar colonies: Lenticular

to irregular, or spherical, white, granular, entire

Broth Uniform turbidity. Fecal odor.

Broth Uniform turbidity. Fecal odor. Milk Alkaline; casein slowly precipitated, with yellowish supernatant fluid Indole is formed in abundance.

Acid and gas from glucose and lactose. Sucrose and dulcitol not fermented. Cultures have odor of valerianic acid.

Grows at 22°C and at 37°C

Anaerobic.

Source: From human feces.

Habitat: Not determined, other than
this source.

45 Clostridium angulosum (Distaso) Hauduroy et al (Bacillus angulosus Distaso, Cent f Bakt, I Abt, Ong., 62,

sus Bergey et al , Manual, Ist ed., 1923, 260; Hauduroy et al., Diet. des Bact. Path , 1937, 91) From Latin angulosus, having angles, hooked.

Rods: Short, thick, with rounded ends, occurring singly and in pairs Long rods sometimes bent to form an obtuse angle. Encapsulated. Non-motile. Spores very small, spherical, terminal, sightly

swelling rods Gram stain not recorded.

Plain gelatin: No growth at 20°C or at
37°C.

Glucose gelatin: Grows well at 37°C.
Growth cloudy at first, then clears and
liquefics, with whitish, powdery precipitate

Glucose agar deep colonies: Large,

angular, opaque, yellowish. Gas bubbles are formed.

Broth : Turbid

Litmus milk: Acid and coagulated in 14 days.

Indole is formed.

Acid and gas from glucose, lactose and sucrose. Butyric acid is formed.

Congulated albumin not liquefied. Odor of skatol.

Optimum temperature 37°C

Anaerobic.

Distinctive character: Resembles the Bacille neigeux, Jungano, Compt. rend. Soc. Biol , Paris, 62, 1907, 677, in form. but not in other respects.

Source : From human feces.

Habitat: Not determined, other than this source

46. Clostridium putrefaciens (Mc-Bryde) Sturges and Drake putrefaciens McBryde, U S D A , Bur. An Ind , Bull 132, 1971, 6; Sturges and Drake, Jour. Bact , 14, 1927, 175, Palmula nutrefaciens Prévot. Ann. Inst. Past . 61, 1938. 89; Acuformis putrefaciens Prévot, Man d Class, etc., 1940, 165) From Latin, putrefying.

Description from McBryde (loc. cit.) and amplified from Sturges and Drake

(loc. cit.).

Rods 0 5 to 0 7 by 3 0 to 15 0 microns, rounded ends, occurring singly, in pairs, and in chains and filaments. Non-motile Spores spherical, terminal, swelling rods Gram-positive

Gelatin: Liquefied

Agar surface colonies (anaerobic) Small, filamentous.

Agar slant (anaerobic) Scanty, white, beaded, glistening growth

Bmth Moderate turbidity Heavy. flocculent sediment.

Litmus milk: Rennet coagulation, peptonized Litmus reduced

Indole not formed.

Nitrites not produced from nitrates Slight production of hydrogen sulfide. Acid and gas from glucose Lactose, sucrose, maltose and starch not fermented.

Coagulated albumin liquefied.

Blood serum liquefied.

Brain medium blackened and slowly digested.

Minced pork medium · Slight disintegration; sour, putrefactive odor,

Non-pathogenic.

Optimum temperature 20°C to 25°C. Slow growth at O°C and no visible growth at 37°C.

Angembic

Source: From muscle tissue of hogs at slaughter.

Habitat: Not determined, other than this source.

47. Clostridium nigrificans Werkman and Weaver. (Iowa State Coll. Jour. Sci., 2, 1927-28, 63; Werkman, Iowa State Coll. Research Bull. 117, 1929, 165.) From Latin niger, black and faciens, making.

Rods: 03 to 0.5 by 3.0 to 6.0 microns. with rounded ends Motile. Spores oval, subterminal, slightly swelling rods. Gram-positive.

Gelatin: Not liquefied.

Deep agar colonies: Show blackening of medium around colonies. Black increased by adding 01 per cent ferric chloride to medium.

Milk: Not recorded

Indole not formed.

Nitrites not produced from nitrates. Glucose not fermented

Carbohydrates not fermented.

Coagulated albumin not liquefied.

Blood serum not liquefied. Brain medium blackened but not

digested. Hydrogen sulfide produced

evstine.

Non-pathogenic to man, guinea pig, mouse, rat and rabbit.

Optimum temperature 55°C. Thermophilic, growing at 65°C to 70°C.

Anaerobic. Distinctive character: Black colonies

ın agar media.

Source: Emm cannel corn showing sulfur stanker spoilage, also accessonally from soil and manure.

Habitat · Presumably soil, although de tected with great difficulty.

48. Clostridium belfantii (Carbone and Venturelli) Spray, (Bacillus belfantis Carbone and Venturelli, Boll 1st Sieroter Milan & 1995 50; not Racellus belfantu Mignia Syst d Bakt 9 1900 767. Spray, in Manual, 5th ed . 1939, 759, Endosporus belfantis Prévot, Ann Inst Past . 61. 1938, 75 ) Named for Belfants. an Italian bacteriologist

Rods, 04 to 06 by 15 to 70 membs thick and straight, occurring singly, in pairs and in short chains Spores large, oval, central to subterminal. swelling rods Usually Gram-negative, occasional cells Gram-positive

Granulose reaction negative

Gelatin . Not liquefied

Plain agar surface colonies (anaerobic) Large, round, opaque, with filamentous edge

Deep agar colonies. Arborescent along the stab. Gas is formed.

Plain broth · Diffuse turbidity, clearing by precipitation No pigmentation Gas is formed.

Potato mash Forms a foam becoming violet in 24 to 48 hours, persisting 3 to 6 days, but disappearing on exposure to air.

Potato slant: Grayish pellicle, becoming violet in 24 to 48 hours. Gas of alcoholic odor is produced No acetone Glycerinated potato. Thin, grayish

pellicle, not becoming violet. Milk Coagulated in 24 to 48 hours.

Clot broken by gas. Milk agar: Abundant growth

butyric odor is liberated. · Indole is formed

Hydrogen sulfide not formed. Acid and gas from glucose, fructose, maltose, sucrose, lactose and mannitol Starch and inulin weakly fermented.

Coagulated albumin not liquefied Blood serum not liquefied Grows well at 37°C.

Annembic

Specifically applytinated only by homol ogous antiserum

Source From retting beds and from our Habitat Not determined other than these sources

None Six other strains of similar nic. menting, sporulating anaembes are described by the authors. These have the conoral characters of Clastridium helfants but differ in certain particulars such as color of pigment, fermentation and specific applutination Present information does not permit accurate systematic differentiation

48a Clostridium magazuras (Carbone and Venturella) Spray (Bacillus maggiarai Carbone and Venturelli, loc cil 59. Spray, in Manual, 5th ed , 1939, 759. Endosnorus magnoras Prévot, loc cel . 76 ) Named for Maggiora, an Italian bacterio ocist

Characters in general those of the group, but does not produce indole Violet prementation persisting only 24

hours

No alcoholic odor from cultures Specifically agglutinated only by homol orous antiserum

From mad from bed of stream in Italy

48b Clostridium derossii (Carbone and Venturelli) Spray (Bacıllus de rossu Carbone and Venturelli, loc cit. 59: Spray, in Manual, 5th ed., 1939, 760, Endosporus rossu Prévot, loc cut , 76 ) Named for G de Rossi, an Italian bacteriologist

Characters in general those of the group Greenish pigmentation on potato slant, changing to violet or orange

Indole is formed Spedifically agglutinated only by homologous antiserum

From soil in Italy.

48c Clostridium ottolenghii (Carbone and Venturelli) Spray. (Bacillus ottolenghii Carbone and Venturelli, loc cit , 59, Sprsy, in Manual, 5th ed , 1939, 760, Endosporus ottolenghii Prévot, loc. cit., 76.) Named for Ottolenghi, an Italian bacteriologist.

Characters in general those of the group. Potatoslant digested to a grayishbrown mash. Greenish pigment changing to reddish. Gas of disagreeable odor is formed.

Indole is formed,

Specifically agglutinated only by homologous antiscrum.

From mud from bed of a stream in Italy.

48d. Clostridium paglianii (Carbone and Venturelli) Spray. (Bacillus paglianii Carbone and Venturelli, loc. cit., 60; nio Carbone and Venturelli, loc. cit., 60; nio Bacillus paglianii Trevisan, I genori e le specio delle Batteriacce, 1889, 19; Spray, in Manual, 5th cd., 1939, 760; Endosporus paglianii Prévot, loc. cit., 76.) Named for Pagliani, an Italian bacteriologist.

Characters in general those of the group. One or two subterminal spores are said to be formed.

Greenish pigmentation on potato,

browning with age.
Indate is formed.

Specifically agglutinated only by homologous antiserum.

From soil in Italy.

48c. Clostridium lustigii (Carbone and Venturelli) Spray. (Bacillus lustigii Carbone and Venturelli, loc. cit, 50; not Bacillus lustigii Trevisan, in Ilit quoted from DeToni and Trevisan, in Sacardo, Sylloge Fungorum, 8, 1889, 958, not Bacillus lustigi Chester, Man. Determ. Bact., 1901, 304; Spray, in Manual, 50; 61, 1939, 760; Endosporus lustigii Prévot, loc. cit., 76) Named for Lustig, an Italian bacteriologist.

Characters in general those of the group. Green pigmentation on potato slant.

Indole is not formed.

Specifically agglutinated only by homologous antiserum.

From mud and soil in Italy.

48f. Clostridium sclavoi (Carbone and Venturelli) comb. nov. (Bacillus sclavoi Carbone and Venturelli, loc. cit., 60; Endosporus sclavoci Prévot, loc. cit., 76.) Named for Sclavo, an Italian bacteriologist.

Characters in general those of the group. Greenish to brown pigmentation on potato short.

Indole is not formed.

Specifically agglutinated only by homologous antiserum.

From retting flax in Italy.

Clostridium venturelli (de Tomasi)
 Spray. (Bacillus venturelli de Tomasi,
 Boll. Ist. Sieroter. Milanese, 4, 1925,
 203; Endosporus venturelli Prévot, Ann.
 Inst. Past., 61, 1933, 76; Spray, in
 Manual, 5th ed., 1937, 760.) Named for
 Venturelli, an Italian bacteriologist.

Rods: Pleomorphie, fusiform to straight or slightly curved, with rounded ends. Size variable with medium, 05 to 08 by 2.5 to 8.0, and up to 20 Omicross. Occurring singly, in pairs, in chains, or frequently in parallel groupings. Mottle. Capsulated. Spores oval, central to exception, and the property of the control of the conception and control of the con

centric, swelling rods. Gram-negative. Granulose reaction positive; showing

violet granules with sodine. Gelatin: No growth; no liquelaction.

Glucose agar surface colonies (anacrobic): Round, becoming rose-colored. Plain agar slant (anaerobic): No

growth.

Maltose agar stab: Colonies lenticular,
yellowish, turning to rose. Odor of

acetone. Plain broth: No growth.

Potato slant (anaerobic): Becomes mucilaginous. Bubbles of gas of amylic oder.

Potato mash: Very abundant growth; rose color, with red spots.

Milk with CaCO: Congulated; becoming yellow, then pale rose. Amylic odor.

Acid and gas from glucose, maltose, sucrose, fructose, lactose, inositol, dertrin and starch. Arabinose, glycerol, mannitol and inulin not formented (cited from Weinberg et al., Les Mic. Anaer., 1937, 890). Fermentation products include especially acetone and amyl alcohol, and smaller amounts of propyl, butyl and isobutyl alcohols, and acetic acid.

Coagulated albumin not digested. Blood serum not liquefied, forms a

small amount of yellowish liquid.

Optimum temperature 18°C to 20°C
Inhibition of growth and pigmentation

above 25°C Anaerobic

Distinctive character. Forms a rosecolored pigment which is soluble in alcohol, but not in water, ether or chloroform-Source 'From potato

Habitat. Not determined, other than this source.

50 Clostridium roseum McCoy and McClung. (Arch f. Mikrobiol, 6, 1935, 237) From Latin roseum, pink.

Rods: 0.7 to 0.9 by 3.2 to 4.3 microns, occurring singly, in pairs and in short chains Motile with pertitichous flagella Spores oval, subterminal, swelling rods to clostridia Gram-positive, becoming Gram-negative

Granulose reaction positive in clostridial stage

Glucose gelatin · Liquefied.

Plain agar slant (anaerobic). Surface growth scant, scarcely perceptible

Glucose agar surface colonies (anaerobie) · Raised, smooth, edges slightly irregular Pink to orange pigment Deep glucose agar colonies . Compact,

lenticular, pink to red-orange. Blood agar not hemolyzed

Pigmentation (anserobic) Colonies red-orange, becoming purplish-black on agration

Plain broth . No growth.

Glucose broth: Abundant, uniform turbidity, with much gas

Litmus milk. Stormy coagulation. Litmus reduced, but obscured by pink pigment Clot slowly softened Proteolysis demonstrable on milk agar.

Potato · Rapid digestion to a clear yellow fluid and bluish sediment. Much gas with butylic odor. Corn mash: Resembling reaction of Clostridium acetobutylicum, but with flesh-orange pigment, becoming slowly purple at surface on ageing.

Hydrogen sulfide formed from thiosulfate and sulfite

Nitrates reduced to ammonia.

Nitrites reduced to ammonia.

Indole not formed.

Acid and gas from xylose, arabinose, glucose, mannose, fructose, galactose, lactose, malactose, malactose, malactose, malactose, dettrin, glycogen, inulin, pectin and salicin Esculin and amygdalın weakly fermented Mannitol, erythritol, glycerol, a-methyl glucoside, Ca-lactate and cellulose not fermented.

Coagulated albumin cubes · Softened and yellowed by slow digestion

Blood serum not liquefied.

Brain medium not blackened or digested

Non-pathogenic for guinea pig and rabbit

Optimum temperature about 37°C.

Growth occurs from 8°C to 62°C.

Anaerobic.
Source. From German maize
Habitat. Probably occurs in soil.

51. Clostridium chromogenes Prévot. (Chromogenie anaerobe, Ghom and Mucha, Cent f Bakt, I Abt, Orig., 42, 1906, 406; Bacillus anaerobius chromogenes LeBlaye and Guggenheim, Man. Prat. d Diag Bact, 51, 1933, 85) From Latin, color-producing.

Rods Moderate size, coccoid to elangate, ends rounded to slightly pointed; straight to slightly curved Occurring singly, paired, in short chains and in long, curved to coiled filaments Capsulate, especially in serum media. Motile, with many peritrichous flagella spores abundant, oval, central, subterminal, to apparently terminal at maturation, swelling rods to clubs and clostradia Grampositive

Granulose negative with iodine solution.

Gelatin: Liquefied in 48 hours. Diffuse turbidity, clearing with abundant, whitish-gray sediment, which later becomes red to violet-red. Upper (1 cm) layer shows diffuse, red pigment.

Deep plain agar (without peptone): Growth sparse. Pigment not formed in absence of peptone.

Blood agar surface colonies (anaerobic): Grayish, moist, shining, flat; edges lobate with finely dendritic-tufted edges. Blood agar is bemolyzed.

Glucose agar surface colonies (anaerobic): As on blood agar.

slightly less profuse.

Glucose agar deep colonies: Gravishwhite, multi-lobate, with dense center and dendritic, tufted edges. Growth begins about I cm below surface. Gas abundantly formed. Diffuse, red pigment appears in superficial layers after 4 to 5 days.

Glucose meat-infusion broth: Abundant, diffuse turbidity with much gas. C 1 . I need on and montation but with

times fails At best, moderate turbidity and sediment. No gas.

Synthetic fluid media (Uschinsky, etc ): No growth (unless peptone is added). Growth is proportionate to added neptone

Potato slaut (anacrobic): Growth del1-Fecal cate, shining, grayish-yellow odor.

Milk: Spongy coagulation after 3 to 4 days. Abundant gas. Turbid, yellowish whey is expressed. Casein clot gradually digested in 4 to 5 weeks Fecal odor.

Indole is not formed.

Hydrogen sulfide is abundantly formed Congulated albumin (hydrocoel- and ascitic-fluid): Digested and blackened, with moderate gas of fecal odor. When covered with agar, the agar plug shows diffuse, red pigmentation

Pathogenicity: Weakly pathogenic for white mice and guinea pigs. Produces hemorrhagic, serous peritonitis after intraperitoneal inoculation. Death due apparently to a weak toxin. Virulence increased by animal passage.

Grows well at 21°C and at 37°C

Angembic

Distinctive character: Red pigmentstion which is increased on addition of chlorine-, or of bromine-water. Although produced by an anaerobe, pigment appears only in scrated zone and depends on peptone content of medium.

Source: From pus of a human peri-

nephritic abscess.

Habitat: Not determined, other than this single source.

52. Clostridium felsineum (Carbone and Tombolato) Bergey et al. (Bacillus felsineus Carbone and Tombolato, Le Staz. Sper. Agrar., Ital., 50, 1917, 563, Ruschmann and Bayendamm, Cent. f. Bakt., II Abt., 64, 1925, 340; Van der Lek, Thesis, Delft, 1930, (143?); Clostridium felsinus Bergey et al., Manual, 3rd ed., 1930, 453.) Named for Felsinea, the ancient name of Bologna, Italy,

Described from Ruschmann and Bayendamm (loc cit.), from the Kluyver strain used by Van der Lek (loc. cit.), and from McCoy and McClung, Arch. f. Mikro-

biol., 6, 1935, 230.

Rods. 03 to 0.4 by 3.0 to 50 microns, occurring singly, in pairs and in short chains. Motile with peritrichous flagella. Spores oval, subterminal, swelling rolls to clostridia. Gram-positive, becoming Gram-negative.

Granulose positive in the clostridial

stage. Glucose gelatin: Liquefied.

Plain agar slant (anaerobic): Surface growth scant, scarcely perceptible.

Glucose agar surface colonies (anaerobic): Raised, smooth, slightly irregular, vellow-orange.

Deep glucose agar colonies: Compact, lenticular, opaque, yellow,

Blood agar not hemolyzed.

Pigmentation (anserobic): orange, ageing to brownish. Not changing on aeration

Plain broth No growth.

Glucose broth; Abundant, uniform turbidity, with much gas. Yellow slimy

Litmus milk: Acid and coagulation.

Litmus reduced. Clot torn and yellowed

No visible direction.

Potato · Digested to a yellow slime

Corn mash: Resembling reaction of Clostridium acetobutylicum, but with flesh to prance nigment.

Indole not formed

Natrates reduced to ammonia

Nitrates reduced to ammonia

Acid and gas from arabinose, vylose, glucose, mannose, fructose, galactose, lactose, maltose, suerose, raffinose, starch, dextrin, inulin, glycogen, pectin and salicin. Mannitol, erythntol, glycerol, Calactate and cellulose put fermented

Fermentation products include butyl and ethyl alcohol, acetone, organic acids (probably butyric and acetic), H<sub>2</sub> and

Coagulated albumin cubes Softened and vellowed by slow digestion

Blood sorum not liquefied

Brain medium not blackened or

Non-pathogenic for guinea pig and rabbit

Grows at 37°C.

Anaerobie.

Source From retting flax

Habitat. Not determined Found in soil in Italy, Argentina and in the United States

53 Clostridium carbonel Arnaudi (Soc Intern. Microbool, Boll Sez Ital, 8, 1936, 251, and Boll Ist Steroter, Milano, 16, 1937, 659, Inflabilis carbones Prévot, Man. d Class, etc., 1940, 96) Named for Carbone, an Italian bacteriologist

Rods: 08 to 10 by 3.5 to 45 microns, with ends slightly tapered Kon-motile Spores oval, terminal, 08 to 10 by 10 to 1.75 microns, swelling rods. Grampositive. Granulose reaction strongly positive

Gelatin : No growth

Glucose and lactose gelatin No growth. Plain agar surface colonies (anaerobic) Flat, shining, colorless, with irregular

Malt agar surface colonics (anaerobic) -Creamy to slightly reddish colonies with irregular edges.

Roux-potato slant (anzerobic) Punctiform, raised, opaque, deep red colonies, becoming almost violet

Plain agar stab Only traces of growth along stab.

Glucose and maltose agar stab: No growth.

Plain broth Very slight, colorless, diffuse turbidity

Glucose broth Very slight turbidity. Maltose broth Intense turbidity, with profuse, reddish-yellow sediment

Tarozzi broth . Slight, diffuse turbidity.

Hydrogen sulfide not formed.

Milk Soft coagulation, with slight,

fine reddish floculence Whey turbid and colorless Reaction acid Clot not digested

Digest-milk (optimum medium) Very abundant turbidity, with bright red flocculent sediment, diffusing uniformly on shaking

Coagulated egg-yolk broth Slight turbidity, no digestion

Congulated egg-albumin broth Slight

Coagulated serum (Loeffler, anaerobic)
Poor growth, flat, red surface colonies
No digestion

Brain medium Not recorded

Cellulose not attacked. Hemp is not

Ferments weakly Glucose, maltose, sucrose, galactose, fructose and raffinose. Slow and partial fermentation of lactose (only in acidified medium). Starch slightly fermented. Fermentation products include II, CO<sub>2</sub>, CII<sub>4</sub>, butyric acid and traces of ethyl alcohol Non-pathogenic for sheep, rabbit, guinea pig or white mouse.

Optimum reaction pH 7.0 to 7.2; minimum pH 6.0; maximum pH 8.0.

Optimum temperature 37°C. Grows slowly at 25°C to 30°C; growth ceases at 40°C.

Anacrobic.

Distinctive character: Production of a brilliant red pigment, soluble in amyll alcohol, petrol-ether, xylol and aniline oil. Partly soluble in ether, chloroform and accione. Pigment very stable in light.

Source: From macerated raw potato infusion.

Habitat: Not recorded, other than from this single source.

54. Clastridium spumarum (Prévot and Pochon) comb. nov. (Plectridium spumarum Prévot and Pochon, Compt. rend Soc. Biol., Paris, 180, 1939, 966.) From Latin, foam or froth.

Rods: 0.5 by 40 microns, motile. Spores are oval and terminal, swelling

rods. Gram-positive

Gelatin · Liquefied in 15 days.

Deep agar. Forms small cottony colonies and a few gas bubbles.

Peptone water. Turbidity and slight sediment.

Milk. Congulated in 5 days, but clot is not digested.

Indole is produced.

Hydrogen sulfide is formed (medium not stated)

Sugars not attacked immediately after isolation.

After 1 month cultivation, ferments slowly glucose, fructose, galactose, maltose, arabinose, xylose, sucrose, mannitol and starch. Inulin is not fermented.

Cellulose (in synthetic medium) is fermented chiefly to acetic and butyric acids, together with inflammable gas and traces of ethyl alcohol.

Congulated albumin not attacked.

Brain medium not blackened.

Optimum temperature around 37°C. Not thermophilic. Anaerobic.

Distinctive characters: Does not produce pigment, and ferments a variety of carbohydrates.

Source: From the scum of sugar refining vats.

Habitat: Not determined, other than from this source.

55. Clostridium werneri Bergey et al. (Bacillus cellulosam fermentans Werner, Cent. f. Bakt., II Abt., 67, 1926, 297; Bergey et al., Manual, 3rd ed., 1939, 452; Bacterium cellulosam Jepson, Bull. Enlownol. Res., 28, 1937, 163; Terminosporus cellulosam fermentans Prévot, Ann. Inst. Past., 61, 1938, 56; Terminosporus cellulosam fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classeam-fermentans Prévot, Man. d. Classicated this forganism.

Related species: Probably closely related to Clostridium omelianskit.

Rods: 0.5 to 0.7 by 1.5 to 7.0 microns, occurring singly and in pairs, but not in chains. Mottle with peritrichous flagella. Spores oval, terminal, swelling rods. Gram-negative.

Cellulose agar slant (anacrobic): Growth only in contact with cellulose. Growth grayish black; agar is darkeaed. Gas is formed.

Agar slant (anaerobic): No growth

Broth: No growth.

Broth with filter paper: Poor growth; cellulose weakly attacked.

Omelianski solution with filter paper: Abundant growth; cellulose digested with formation of H<sub>2</sub> and CO<sub>2</sub>.

Hydrogen sulfide is formed in the Omehanski medium, presumably from the (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and MgSO<sub>4</sub>.

Glucose not fermented.

Carbohydrates, other than cellulose, not fermented

Non-pathogenic for mice.

Optimum temperature 33°C to 37°C. Annerobic.

Source · From larvae of rose leaf beetle (Potosia cuprea). Habitat: Occurs in soil and in feces of

56. Clostridium cellulosolvens Cowles and Rettger (Jour. Bact., 21, 1931, 167; Caduceus cellulosolvens Prévot, Ann Inst. Past , 61, 1938, 86.) From chemical torm. cellulose, and Latin. dissolving.

term, celtulose, and Latin, dissolving.
Rods. 0 5 by 2.0 to 6.0 microns, commonly curving, occurring singly and in pairs, not in chains. Non-motile Spores spherical, terminal, swelling rods Gramstain uncertain: usually Gram-perative.

Does not grow in routine media, except where cellulose or certain few carbohydrates are added.

Surface colonies on dextrin-cysteine meat infusion agar (anaerobic) Tuny, round, transparent dew-drops; finely granular, with smooth edge.

Acid and gas from cellulose, dextrin, arabinose, xylose and soluble starch. Gluccose, Iructose, mannose, lactose, mai-tose, sucrose, melezitose, raffinose, inulin, salicin, amygdalin, adontol, dulettol, erythritol, glycerol, inositol, mannitol, sorbitol and gum arabir not fermented

Cellulose decomposed to H1, CO2 and

Grows at 37°C.

Angemilie

Source · From horse feres.

Habitat Not determined, other than this source. Probably widely dispersed in manufed soil

57. Clostridium dissolvens Bergey et al. (Bactilus cellulosa dissolvens Khouvine, Ann. Inst. Past., 37, 1923, 711, Bergey et al., Manual, 2nd et, 1925, 344; Caduceus cellulosae dissolvens Prévot, Ann Inst. Past., 61, 1938, 80.) From Latin, dissolving.

Rods. Slender, ranging from 2.5 to 12 5 microns in length, occurring singly, occasionally in pairs, but not in chains. Non-motile Spores oval, terminal, swelling rods Gram-negative.

Cellulose is digested by the formation of an endocellulase which acts only when the bacteria are attached to the cellulose. Saccharides are formed from cellulose, also CO<sub>2</sub>, H<sub>2</sub>, ethyl alcohol, acetic, lactic and butteric soids

A yellow pigment is formed in presence

Clucase not fermented

Carbohydrates, other than cellulose,

Non-pathogenic for gumea pig.

Optimum temperature Grows between 35°C and 51°C, without a definite

optimum Apperable

Distinctive character Grows only in media containing cellulose, in the presence of which it produces a yellow perpent.

Source From human feres.

Habitat · Intestinal canal of man

58. Clostridium omelianskii (Henneberg emend. Clausen) comb. nov lulose fermenting microbe, Omelianski, Compt. rend. Acad Sci . Paris, 121, 1895. 653 (Racillus fermentationis cellulosae Omelianski, Arch Sci Biol. (Russ.), 7. 1899, 419; Bacterium cellulosis Migula. Syst. d Bakt . 2, 1900, 513); Bacille hydrogénique, Omelianski, Arch. Sci. Biol. (Russ ), 9, 1902-03, 263 (Wasserstoffbacil-Ins. Omelianski, Cent. f. Bakt., II Abt., 8, 1902, 262; Bacillus fossicularum Lehmann and Neumann, Bakt Diac. 4 Aufl . 2, 1907, 466, Bacillus hydrogenis Jungano and Distaso, Les Anaérobies. 1910. 147: Bacillus omelianskii Henneberg, Cent f Bakt, II Abt, 55, 1922, 276, emend Clausen, Cent f Bakt II Abt . 84, 1931, 40 and 54, Omelianskillus hudrogenicus Heller, Jour. Bact . 7, 1922, 5. Caduceus cellulosae hydrogenicus Prévot. Ann. Inst Past , 61, 1938, 86); Bacille formenique, Omelianski, Arch. Biol (Russ), 9, 1902-03, 263 Methanbacillus, Omelianski, Cent. f Bakt , II Abt , 11, 1903-01, 370, Bacillus methanigenes Lehmann and Neumann. Bakt Diag , 4 Aufl , 2, 1907, 466, Cellobacillus methanigenes Orla-Jensen, Cent. f. Bakt , II Abt., 22, 1909, 343; Bucillus methann Jungano and Distaso, Lea

Anaérobies, 1910, 146; Caduceus cellulosae hydrogenicus var. cellulosae methanicus Prévot, Ann. Inst Past., 61, 1938, 86; Caduceus cellulosae methanicus Prévot. Man. d. Class., etc., 1940, 150).) Named for Omelianski, the Russian bacteriologist who first described this type.

This species was apparently first isolated and studied in pure culture by Clausen (loc. ctl.). From his studies he concludes that Omelianski's Wasserstoffand Methanbacillus are but a single species, and that the gaseous fermentation products (H:, CO, and CIL) were affected by the symbiotic forms always present in Omelianski's cultures.

His evidence is quite convincing, and the organism is presented here from his description.

Rods: Length varying with the medium, 0 5 to 0 7 by 5.0 to 15.0 microns. straight to slightly curved. Decurring chiefly singly, occasionally in pairs, frequently parallel in groups, never in chains or filaments. Young cells motile, but motility disappearing with sporulation. Flagella not demonstrable. Spores spherical, terminal, swelling Spores 10 to 15 microns in diameter, varying with medium, Gram-positive, becoming Gram-labile on sporulation

Young vegetative cells colored wine-red with jodine solution.

Gelatin (plus asparagine): Liquefied in 6 to 10 days. Medium remains perfectly clear.

Asparagine agar deep colonies : Gravishwhite, delicate, cottony, with fine radial outgrowths

Asparagine agar surface colonies (anaerobic) · Poor growth, delicate, translucent, filmy, scarcely discernible.

Cellulose-liver broth · Solution remains visibly clear and does not darken with age. Occasional large gas bubbles arise.

Indole not formed. Ammonia not formed

Nitrates not reduced to nitrites Traces of HtS produced in thorganic

solutions.

Milk: Soft coagulation in 24 hours.

Amorphous clot shrinks and settles, forming a vellowish-red to orange sediment. with turbid supernatant whey.

Brain medium: Not digested or blackened; no visible evidence of growth

None of the following carbohydrates attacked: Maltose, mannitol, lactose, glucose, sucrose, galactose, fructose, starch, salicin, glycerol and inulin.

Cellulose apparently the primary Csource, but is only weakly attacked by pure cultures.

Yellow pigment not recorded in presence of cellulose lace Clastridium dissolvens).

Non-pathogenic for mice; other animals not recorded.

Optimum reaction pH 7.9 to 7.4; grows between pH 6.0 and 8.4

Optimum temperature 37°C to 42°C. Annerobic: Growing at 25 to 30 mm mercury pressure.

Distinctive characters: Ability to . . - stante to on

without requiring presence of cellulose. Spores resist beating at 100°C for 90 minutes.

Source: From human, cow and horse excreta, from cow's stomach' contents, from cheese and from soil.

Habitat: Intestinal canal of animals, and presumably thence widely disseminated in soil.

59 Clostridium carnis (Klein) Spray. (Art V. von Hibler, Cent f. Bakt., I Abt., 25, 1899, 515; Bacillus carnis Klein, Cent. f. Bakt , I Abt., Orig , 35, 1904, 459, also Trans. Path. Soc., London, 55, 1901, 74, Art. VI, von Hibler, Untersuch, u. d. Path. Anger, 1908, 3 and 406; Hiblerillus sextus Heller, Jour Bact , 7, 1922, 6; Bacillus lactiparcus Lehmann and Sussmann, in Lehmann and Neumann, Bakt. Diag , 7 Aufl , 2, 1927, 647; Plectridium carnis Prévot, Ann. Inst. Past, 61, 1938, 87, Spray, in Bergey et al., Manual, 5th ed , 1939, 750, Clostridium

sextum Prévot, Man. d Class, etc., 1940, 136.) From Latin, of flesh.

Description from Hall and Duffett,

Jour. Bact, 29, 1935, 269.

Rods: 0 5 to 0.7 by 1 5 to 4 5 microns, occurring singly, in pairs, rarely in chains of 3 to 4 cells. Motile with peritrichous flagella. Spores oval to elongate, subterminal, slightly swelling rods Gram-positive.

Gelatin: Not liquefied or blackened (aerobic) Agar surface colonies Minute, transparent dew-drops, becoming flat and lobate.

Blood agar surface colonies (aerobic) Similar to plain agar Slight hemolysis. Deep agar colonies : Lenticular, becom-

ing nodular to arborescent Milk: Abundant gas, but no coagulation

or other change. Indole not formed.

Acid and gas from glucose, galactose, fructose, maltose, lactose, sucrose, amygdalın, salıcin and dextrin Trehalose, raffinose, vylose, arabinose, starch, inulin, mannitol, dulcitol, sorbitol, glycerol and mositol not fermented.

Coagulated albumin not liquefied

Blood serum not inquefied.

Brain medium not blackened or digested Pathogenic for guinea pig. white rat and

rabbit. Forms an exotoxin of moderate intensity, producing edema, necrosis and death on sufficient dosage Grows well at both 37°C and at room

temperature

Angerobic and microaerophilic, growing delicately on aerobic agar slants.

Source: Originally isolated from a rabbit inoculated with garden soil (von Hibler); from contaminated beef infusion (Klein)

Habitat : Probably occurs in soil

60 Clostridium histolyticum (Weinberg and Seguin) Bergey et al (Bacıllus histolyticus Weinberg and Seguin, Compt rend. Acad. Sci , Paris, 163, 1916, 419; Weinbergillus histolyticus Heller, Jour Bact., 7, 1922, 9; Bergey et al , Manual, 1st ed., 1923, 328 ) From Greek, tissuedissolving.

Rods . 0 5 to 0 7 by 3 0 to 5 0 microns. occurring singly and in pairs. Motile with peritrichous flagella. Spores oval. subterminal, swelling rody. positive

Gelatin Complete liquefaction in 24 hours Blood agar surface colonies (aerobic):

Minute, round dew-drops. Blood is hemolyzed. Deep agar colonies Variable; from len-

ticular, lobate, to fluffy, according to the agar concentration.

Agar slant (aerobic) Grows aerobically in barely perceptible film, or in tiny. smooth, discrete colonies

Broth Turbid, with slight precipitate. Indole not formed.

Nitrates not produced from nitrates Litmus milk. Softly coagulated, then

slowly digested. Little gas is formed. Carbohydrates are not fermented. Coagulated albumin slowly liquefied

Blood serum slowly liquefied with darkened, putrid fluid Brain medium blackened and digested

with putrefactive odor. Egg-meat medium · Little gas is formed.

Meat first reddened, then darkened in 3 days Digestion apparent in about 24 hours Nauseous odor Tyrosin crystals are abundant after about a week for small laboratory Pathogenic

animals Produces a cytolytic evotoxin which causes extensive local necrosis and sloughing on injection Not toxic on feeding Gmus well at 37°C.

Annerobic and microaerophilie. Grows feebly on aerobic agar slant.

Source · Originally isolated from war anunds, where it induces active necrosis of tissue

Habitat, Not determined, other than source stated Found occasionally in feces and soil. Apparently widely, but sparsely, dispersed in soil.

Bacillus dimorphobulyricus Lehmann and Neumann. (Dimorpher Buttersäurebacillus, Grassberger and Schattenfrob, Arch. f. 11yg., 80, 1907, 59; Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 441.) From milk.

Bacillus elegans Romanovitch. (Compt. rend. Soc. Biol., Paris, 71, 1911, 169.) From normal human intestine and

from diseased appendix.

Bacillus fibrosus Gerstner. (Thesis, Basel, 1894, 26.) From soil and sewage. Bacillus flüggei Migula. (Anaerobe No. IV, Flugge, Zischr. f. Hyg., 17, 1894, 290; Migula, Syst. d. Bakt., 2, 1900, 597.) From boiled cow's milk.

Bacillus fossicularum Lehmann and Neumann. (Wasserstoffbacillus, Omelianski, Cent. f Bakt., II Abt., 8, 1902, 262; Lehmann and Neumann, Bakt. Diag., 4 Aufl., 2, 1907, 466, may have been named in the 3 Aufl.) From mud from canals. Form 3 hydrogen and CO, from anaerobic

cellulose fermentations.

Bacillus funicularis Gerstner. (Thesis, Basel, 1894, 24.) From soil and sewage

Bacillus gangraenae Tilanus. (Nederl. Tildschr v. Geneeskunde, 21, 1885, 110.)

From a gangrenous human leg.

Ba illus gracilis citylicus Achalme and Rosenthal (Compt rend. Soc Biol, Paris, 58, 1906, 1025) From stomach contents in a case of gastritis

Bacillus granulosus Gerstner. (Gerstner, Thesis, Basel, 1894, 21; Bacillus granulatus Migula, Syst d. Bakt, 2, 1900,

613 ) From soil and sewage.

Baullus haumani Soriano (Unnamed pleetridium, Sordelliand Soriano, Comptrend. Soc. Biol., Paris, 99, 1928, 1617, Pleetridio amurillo, Soriano, Tomo enmorativo del XXV universario de fundación de la Facultad de Agronomia y Veternuaria, Buenos Aires, 1929, (?); Soriano, Rev. Inst. Bact., Buenos Aires, 5, 1930, 743, Pleetridium amarillus, 5, 1930, 743, Pleetridium amarillus haumanna Armaudi, Boll Ist Sieroter, Milano, 16, 1937, 650, Clostridium haumanna

Prévot, Ann. Inst Past., 61, 1938, 81.) From flav-retting beds.

Bacillus ichthyismi Konstansoff (Ved.) Prakt. Med., Petrograd, 51, 1915, (7662); quoted from Weinberg et al., Les Microbes Anaérobies, 1937, 341.) From fish responsible for a condition simulating botulism.

Bactllus indolicus Gratz and Vas. (Gratz and Vas, Cent. f. Bakt., II Abt., 41, 1914, 511; Inflabilis indolicus Prévot, Ann. Inst. Past., 61, 1938, 77.) From cheese.

Bacillus infantilism Hill and Whitcomb. (Amer. Jour. Pub. Health, 3, 1913, 926.) From human intestine.

Bacillus infatus Koch. (Koch, Botan Zoit, 46, 1888, 328; Clostridium inflatum Trevisan, I generi el es specie delle Batteriacee, 1889, 22; not Bacillus inflatus Distaso, Ann. Inst. Past., 28, 1909, 985. Anaerobic status insecure; aerobic according to Kruse, in Flugge, Die Mikmorg, 3 Aufi., 2, 1896, 239. Observed in swamp waters, but not isolated. Formed two spores in a spindle-shaped sporancium.

Bacıllus irregularis Choukévitch (Choukévitch, Ann. Inst. Past., 25, 1911, 348; Clostridium irregularis Prévot, Ann Inst. Past., 61, 1938, 85) From large

intestine of horse.

Bacillus kedrowski Migula. (Bacillus No. 2, Kedrowski, Zischr. f. Hyg., 18, 1894, 451; Bacillus acidi butyrici Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 256; not Bacillus acidi butyrici I Weigmann, Cent f. Bakt., II Abt., 4, 1898, 830 (see Bacillus pseudonaricula), Migula, Syst. d. Bakt., 2, 1900, 583) From cheese and rancid butter.

Bacillus lactopropylbutyricus Tissier. (Apparently identical with Bacillus lactopropylbutyricus non liquefaciens Tisser and Gasching, Ann. Inst. Past., 17, 1903, 546; Tissier, Ann. Inst. Past., 18, 1905, 282; Clostridium lactopropylbutylicum Prévot, Ann Inst. Past., 61, 1938, 55; Bacillus lactopropylbutylicus non

liquefaciens Prévot, Man d Class., etc., 1940, 141 ) From milk

Bacillus lichenoides Piening. (Cent. Bakt, I, Abt, Orig, 124, 1932, 217; not Bacillus lichenoides Grohmann, Cent f Bakt, II Abt, 61, 1924, 267) Cited only by name, without description From dried sheep intestines used for preparation of catgut sutures.

Bacillus limosus Klein (Ber d. Deutsch. Bot Gesellsch., ? (Bhft.), 1889, 60) Migula (Syst. d. Bakt., 2, 1900, 640) says this is probably anaerobic. Observed in swamp water, but not cultivated on artificial media

Bacillus longus Chester. (Bacillus muscoules colorabilis Ucke, Cent f. Bakt, I Abt, 23, 1893, 1000; Chester, Man Determ. Bact, 1901, 303) From garden soil.

Bacillus lubinski, Kruse (Tetanusabnlicher Bacillus, Lubinski, Cent f Bakt, 16, 1894, 771; Kruse, in Flügge, Die Mikroorg., 3 Aufl., 2, 1896, 267.) From a fetid human abdominal abscess in peritonitis

Bacillus lyticus Costa and Troisser. (Compt rend Soc. Biol., Paris, 78, 1915, 433) From gangrenous war wounds. Stated to be intermediate between Clostridium perfringens and Clostridium septicum.

Bacillus macrosporus Klein. (Ber d. Deutsch Bot Gesellsch, 7 (Bhft), 1889, 60) Migula (Syst d Bakt., 2, 1900, 640) says this is probably anaerobic. Observed in swamp water, but not cultivated on artificial media.

Bacillus makrono-filiformis Becker (Zischr f Infkrnkh d. Haust , 23, 1922, 20) From a guinea pig cadaver.

Bacillus maymone: Carbone. (Boll. Sez Ital., Soc. Intern. Microbiol., 1, 1929, 74) A retting organism of doubt ful purity and anaerobic status. Cultivated from kenaf (Hibiscus cannabinus).

Bacillus megalosporus Choukévitch (Choukévitch, Ann Inst Past., 25, 1911, 351, Hiberillus megalosporus Heller, Jour Bact, 7, 1922, 17; Inflabilis megalosporus Prévot, Ann Inst. Past., 61, 1938, 77.) From large intestine of horse.

Bacillus multiformis Distuso (Distuso, Cent. f. Bakt., I Abt., Orig., 88, 1911, 101; not Bacillus multiformis van Senus, Dissert , Leiden, 1890, (?); Bacteroides multiformis Bergey, Manual, 1st ed., 1923, 263; Cillobacterium multiforme Prévot, Ann. Inst. Tast., 60, 1938, 297.) Stated by Distaso (foe. cit.) not to produce spores, but to belong probably to the Welch Group. From Grees of dog

Bacillus multiforms van Senus. (van Senus, Dissert., Leiden, 1890 and Koch's Jahrsber, 1, 1890, 138) From mud and from decomposing vegetation

Bacillus muscoides Liborius (Liborius, Ztschr. f. Hyg., 1, 1886, 163, Cornilia muscoides Trevisan, I generi e le specie delle Batteriacee, 1889, 22.) From mouse inoculated with soil, from cheese, and from bovine feces.

Bacillus muscoides non colorabilis Ucke (Cent f. Bakt , I Abt., 25, 1898, 1000 ) From hay infusion.

Bacillus nanus Romanovitch. (Compt. rend Soc. Biol, Paris, 71, 1911, 239) From human intestine.

Bacailus nebulosus Vincent. (Ann. Inst Past 42, 1907, 69; not Bacilus nebulosus Wright, Mem Nat. Acad Sci., 7, 1894, 465, not Bacilus nebulosus Hallé, Thèse de Paris, 1898, 33, not Bacilus nebulosus Migula, Syst d Bakt, 2, 1900, 841; not Bacillus nebulosus Gorsaine, Jour Bact, 27, 1934, 52) From well and river water

Bacallus oedematis Migula. (Bacillus cedematis maligni Liborius, Ztschr. f. Hyg., 1, 1859, 1859, not Bacillus oedematis maligni Zopf, Die Spaltpilze, 3 Auft, 1855, 85, Migula, Syst d Bakt, 2, 1900, 601; not Bacillus oedematis Chester, Man. Determ Bact, 1901, 292)

Bacillus otitidis sporogenes putrificus von Hibler. (Cent f. Bakt, I Abt., Orig, 68, 1913, 282.) From a human brain abseess.

Bacillus otricolare Weinberg and Ginsbourg. (Bacillo otricolare, Nacciarone, Riforma Med., 33, 1917, 778; Weinberg and Ginsbourg, Bull. Inst. Past., 23. 1925, 825; Endosporus otricolare Prevot. Ann. Inst. Past., 61, 1938, 75.) From

human gaseous gangrene.

Bacillus pappulus de Gasperi. (de Gasperi, Cent. f. Bakt., I Abt., Orig., 58, 1911, 1; Paraplectrum pappulum Prévot, Ann. Inst. Past., 61, 1938, 75.) From rancid sausages.

Bacillus parabutyricus Gratz and Vas. (Gratz and Vas, Cent. f. Bakt., II Abt., 41, 1914, 510; not Bacillus parabulyricus LeBlaye and Guggenheim, Man. Prat. de Diag. Bact., 1914, 324.) From Liptauer cheese.

Bacillus penicillatus Gerstner. (Inaug. Diss., Basel, 1894, 27.) From soil and sewage.

Bacillus peroniella Klein. (Ber. d. Deutsch. Bot. Gesellsch., 7 (Bhft.), 1889, Migula (Syst. d. Bakt., 2, 1900. 640) says this is probably anaerobic. Observed in swamp water, but not cultivated on artificial media.

Bacillus polypiformis Liborius. (Liborius, Ztschr f. Hyg., 1, 1886, 162; Cornilia polypiformie Trevisan, I generi e le specie delle Batteriacee, 1889, 22; Angerobe No. II, Sanfelice, Ztschr. f. Hyg., 14, 1893, 369; Bacıllus cephaloideus Migula, Syst. d. Bakt., 2, 1900, 631.) From mouse inoculated with soil.

Bacıllus postumus Heim. (Heim, Lehrbuch d Bakt., 3 Aufl., 1906, (7) (p. 259 in 6 Aufl.); quoted from Würcker, Sitzungsber d. Physik.-Med. Soz. in Erlangen, 41, 1909, 230; also Heim, Cent. f. Bakt., I Abt., Orig , 55, 1910, 841.) From various spontaneously putrelying infusions.

Bacillus pseudomagnus Migula. (Anserobe No VI, Sanfelice, Ztschr. f. Hyg, 14, 1893, 373; Migula, Syst. d. Bakt., 2, 1900, 608; Bacillus caris Chester, Man. Determ Bact., 1901, 293.) From putrefying meat infusions, soil and animal excreta.

Bacıllus pseudonavicula Migula. (Species No. 1, Kedrowski, Ztschr. f. Hyg, 16, 1894, 445; Bacillus acidi butyrici I Weigmann, Cont. f. Bakt., II Abt., 4,

1898, 830; not Bacillus ccidi butyrici Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 256; Migula, Syst. d. Bakt., 2, 1900, 590.) From cheese and rancid butter.

Bacillus pseudooedematis Kruse. (Pseudo - Oedembacillen, Liborius, Ztschr. f. Hyg., 1, 1886, 163; Bacillus pseudo-oedematis maligni Gerstner, Inaug. Diss., Basel, 1894, 35; not Bacillus pseudooedematis maligni Sanfelice, Ann. dell'Ist. d'Ig. di Roma, n.s. 1, 1891, 370; Anaerobe No. VII, Sanfelice, Ztschr f. Hyg., 14, 1893, 374; Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 239; Bacillus pseudoedematis Chester, Man. Determ. Bact., 1901, 293; presumably identical with Bacillus pseudo-senticus Perrone, Ann. Inst. Past , 19, 1905, 371, and, according to Persone, with Proteus hominis capsulatus Bordoni-Ufireduzzi, Ztschr. f. Hyg., 3, 1888, 333 ) From mouse inoculated with soil, from putrelying meat infusions and from animal excreta

Bacillus pseudosolidus Migula. (Auaerobe No. III, Sanfelice, Ztschr. f. Hyg., 14, 1893, 371; Migula, Syst. d. Bakt , 2, 1900, 630; Bacillus tardus Chester, Man. Determ. Bact., 1901, 294; not Bacillus tardus Choukévitch, Ann. Inst. Past., 25, 1911, 350.) From putrelying meat infusions, soil, and from animal excreta.

Bacıllus pseudotetani Mıgula. (Pseudotetanusbacillus, Tavel and Lanz, Mitt a. klin. med. Inst. d Schneiz, 1, 1893, 162; Migula, Syst. d. Bakt , 2, 1900, 598; Bacillus taveli Chester, Man. Determ. Bact., 1901, 304.) From cases of intestinal abscesses.

Bacillus pseudotetanicus Kruse. (Anaerobe IX, Sanfelice, Ztschr. f. Hyg, 14, 1893, 375; Kruse, in Flügge, Die Mikroorg., 3 Aufl., 2, 1896, 267; not Bacillus pseudotetanicus Migula, Syst. d. Bakt., £, 1900, 626; not Bacillus pseudo. tetanicus Chester, Man. Determ. Bact., 1901, 302; Bacillus subictanicus Migula, loc. cit., 629.) From putrefying meat infusions and from soil.

Bacillus putrificus coagulans Distaso. (Cent f. Bakt, I Abt., Orig., 59, 1911, 97.) From human and animal intestine.

Bacillus putrificus var. non liquefaciens Putzu (Policlin., Sez. Chir., 23, 1916, 225.) From human gas gangrene.

Bacillus putrificans immobilis Distaso (Ann Inst Past, 23, 1909, 962) From

the feces of the flying for (Pteropus)

Bacillus pyogenes foelidus Herfeldt
(Cent. f. Bakt , II Abt , 1, 1895, 77)

From manure and from horse intestine Bacillus reniformis Gerstner (Gerstner, Inaug Diss, Basel, 1894, 22, Bacher, Inaug Diss, Basel, Basel, Basel, Bacher, Inaug Diss, Basel, Basel, Bacher, Inaug Diss, Basel, Base

Wchnschr, 65, 1916, 133) From human lesions

Bacullus satellitis Loris-Melikov. (Unnamed species of Loris-Melikov, Compt. rend. Soc. Biol., Paras, 70, 1911, 865; Loris-Melikov, Ann. Inst. Past., 27, 1913, 515, Bacullus satelitis (sic) Loris-Melikov, Compt rend Acad Sci, Paras, 166, 1913, 346, Inflabitus satellitus Prévot, Ann Inst Past, 61, 1938, 77) From human typholoi feces

Bacillus scalologenes Weinberg and Ginsbourg. (Skatol-liberating Clostridium, Fellers, Abst. Bact., 7, 1923,

Cent f Bakt, 11, 1892, 4, Clostridium rubellum Prévot, Ann. Inst. Past, 61, 1938, 85) From dust and dirt

Bacillus saccharofermentans de Gas peri (Compt. rend Soe Biol, Paris, 67, 1909, 494.) From putrefying carcasses of game birds.

Bacillus saccharogenes Romanovitch (Compt rend Soc Biol, Paris, 71, 1911, 168) From human intestine, both nor-

168) From human intestine, both normal and during appendicitis

Bacillus saprogenes I, II and III,

Herfeldt (Herfeldt, Cent f Bakt, II

Herfoldt (Herfoldt, Cent f Bakt, II Abt, I, 1895, 77; not Bacillus saprogents Salus, Arch f Hyg, 61, 1904, 115 From manure and from horse intestine Bacillus saprogents intestinals Ro-

manovitch (Compt rend Soc Biol, Paris, 71, 1911, 237) From human intestine Bacillus saprophylicus Maes (Surg

Clin. North Amer., 10, 1930, 792.) Only casual mention of this organism as one of the common gas bacilli. Otherwise unidentified

Bacillus saprotoricus Strdelli, Soriano, Ferrari and Torino (Sordelli et al , Rev d Inst Bact., Buenos Aires, 6, 1934, 432, Clostridium saprotoricum Prévot, Ann Inst. Past., 61, 1938, 83) From human gascous gangrene

Bacillus sarcoemphysematodes hominis Conradi and Bieling (Munch med Paris, 1927, 54) From spoiled canned macaron; and salmon

Bacillus septeus Klem. (Klein, Micro-Organisms and Disease, London, 1884, 78, not Bacillus septeus Macé, Traité Prat d Bact, 1st ed, 1888, 455, not Bacillus septeus Migula, Syst. d Bakt., 2, 1900, 646) Probably synonymous with Clastidium perfungen Type A From earth, putrid blood and other atbuminous funds, and occasionally in blood-vessels of man and animals after

Bacillus solidus Lüderitz (Lüderitz, Ztschr f Hyg, 5, 1889, 152, not Bacillus solidus Chester, Ann Rept Del Col Agr Exp Sta, 10, 1898, 129, Cornita solida Trevisani, I generi e le specie delle Batteriacee, 1889, 22) From mouse and guinea pig inoculated with soil

Bactlus solmus Klein. (Klein, Ber d Deutsch. Bot Gesellach, 7 (Bhit.), 1889, 69, Duplectridum solmus Fischer, Jahrb f. Wiss Bot, 27, 1895, 1483, Migula (Syst d Bakt, 2, 1900, 640) says this is probably anaerobic Observed in swamp water, but not cultivated on artificial media.

Bacilius spinosus Lüderitz (Lüderitz, Zischr. f. Hyg., 5, 1889, 182; Cornilia spinosa Trevisan, I generi e le specie delle Batteriacce, 1889, 22.) From mouse and guinea pig inoculated with soil

Bacillus sporogenes Migula. (Bacillus enteritidis sporogenes Klein, Cent. f. Bakt., I Abt., 18, 1895, 737; Migula, Syst. d. Bakt., 2, 1900, 560; Bacıllus (enteritidis) sporogenes and Bacillus enteritidis Klein, Loc. Govt. Bd., Ann. Rept. Med. Off., London, \$5, 1903-04, 442 and 443; Bacillus sporogenes capsulatus Rettger. Jour. Biol. Chem., 2, 1906-07, 84; Bacillus enteritidis-sporogenes Holland, Bact., 5, 1920, 218; Clostridium enteritidis-sporogenes Holland, abid., 218; Clostridium enteritidis sporogenes Holland, ibid., 222; Clostridium sporogenes Holland, ibid , 220.) Probably a culture of Clostridium perfringens contaminated with Clostridium bifermentans or with Clostridium sporogenes. From epidemic diarrheal feces, and from milk presumably causing the epidemic

Bacillus sporogenes non liquefaciens Jungano. (Jungano, Compt. rend Soc. Biol., Paris, 65, 1908-09, 716; Bacillus sporogenes liquefaciens Jungano, ibid, 718: Bacillus sporogenes non liquefaciens anaerobius LeBlaye and Guggenheim, Man Prat. d. Diag Bact., 1914, 395 ) From the intestine of the flying for (Pleropus).

Bacillus sporagenes foetidus Chouké-(Ann Inst Past, £5, 1911, 257) From the large intestine of a horse

Bacillus sporogenes parvus Choukévitch. (Ann. Inst Past., 27, 1913, 251.)

From intestine of cattle.

Bacillus stellatus Vincent. (Vincent, Ann. Inst. Past , 21, 1907, 69; Bacillus stellatus anaerobius LeBlaye and Guggenbeim, Man. Prat. d. Diag Bact., 1914, 368; Bacterium stellatum LeBlaye and Guggenheim, idem ) Anaerobic status uncertain, but Vincent compares it with Bacillus polypiformis Liborius, and with Anaerobe No II, Sanfelice. From water.

Bacillus subfoetidus Migula. (Anserobe V, Sanfelice, Ztschr I Hyg, 14, 1893, 372, Migula, Syst. d. Bakt., 2, 1900, 609; Bacillus anaerobic No V Chester, Man. Determ Bact., 1901, 296; Bacellus pseudotetanicus Chester, ibid, 302.) From putrefying meat infusions, soil, and from animal excreta.

Bacillus tachysporus Wesbrook. (Jour. Path. and Bact., 4; 1896-97, 8.) From infection in human tetanus.

Bacillus tenuis glycolyticus Distaso. (Ann. Inst. Past., 23, 1909, 955.) From intestine of the flying for (Pteropus).

Bacıllus tenuis spatuliformis Distaso. (Distaso, Cent. f. Bakt., I Abt., Orig., 59, 1911, 101; Bacteroides tenuis Bergey et al., Manual, 1st ed., 1923, 263; Cillobacterium spatuliforme Prévot, Ann. Inst. Past., 60, 1938, 297; Bacillus spatuliformis Prévot, Man. d. Class., etc., 1940, 79 ) Spores not observed by Distaso, but placed by him in the perfringens-group. From feces of dog.

Bacillus teras Knorr. (Knorr, Cent. f. Bakt., I Abt., Orig., 82, 1918-19, 225; Inflabilis teras Prévot, Ann. Inst. Past, 61, 1938, 77.) From soil and from fluid aspirated in hematopneumothorax.

Bacillus thalassophilus Russell. (Russell, Ztschr. f. Hyg., 11, 1892, 189 ) Variably recorded as a strict or facultative anaerobe (see Bacellus polymyra and Bacillus sphaericus). From sea nater and mud from depth of sea.

Bacillus thermofibrincolus Itano and Arakawa. (Bull. Agric. Chem. Soc., Japan, 5, 1929, 33 ) Source not recorded. Bacillus tympani-cuniculi Morcos.

(Jour Bact., 23, 1932, 454.) From viseera, muscles and blood of rabbits dying of infectious tympanitis.

Bacıllus ukilii Weinberg, Prévot, Davesne and Renard. (Unnamed species of Ukil, Compt. rend. Soc. Biol, Paris, 87, 1922, 1009; Weinberg et al., Ann. Inst. Past., 42, 1928, 1193; Bacillus oedematogenes Frei, Ergeb. d. allgem. Path Mensch. u. Tiere, \$1, 1936, 52, Clostridium ukilii Hauduroy et al., Dict. d. Baet Path., 1937, 142; Clostridium oedematis-benigni Prévot, Ann. Inst.

Bacillus ventriculosus Koch. (1800a, Botan Zert , 46, 1888, 341; Clostridium ventriculosus Trevisan, I generi e le specio delle Batteriacee, 1889, 22.) Probably not anaerobic. Observed in decaying vegetation and in swampy waters.

Bacterium coprophilum Migula. (Anacrobe No. 2, Sewerin, Cent F Bakt., II Abt., 3, 1897, 708; Migula, Syst d. Bakt, 2, 1900, 323; Bacillus coprophilus Weinberg, Nativelle and Prévot, Les Microbes Anaér, 1937, 643.) From horse manure.

Bacterium lini Migula. (Unnamed species of Winogradsky, Compt rend. Acad Sci, Paris, 121, 1895, 744; Migula, Syst d. Bakt, 2, 1900, 513 From retting flax

Bacterium pseudoclostridium Migula (Clostridium foetidum lactis von Freudenreich, Cent f Bakt., II Abt., 1, 1896, 856, Migula, Syst d Bakt., 2, 1900, 511 \cdot From cheese

Bacterium sternbergii Migula (Bacillus anaerobicus liquigatems Sternberg, Researches relating to the etiology and prevention of yellow fever, Washington, 1891, 2814; Bacillus anaerobius liquidciens Kruse, in Flugge, Die Mikroorg, 3 Aufl. 2, 1890, 241, Migula, Syst d Bakt, 2, 1800, 444; Bacterium anaerobieum Chester, Man Determ Bact, 1901, 198) From intestine of a yellow fever eallyer.

Bactralum butyricum Chudiakow. (Chudiakow, Zur Lebre von der Anaerobose, Teil I, Moskau, 1896, (?); quoted from Rothert, Cent f Bakt., II Abt. 4, 1898, 390) Stated by Rothert to be a pathogenic, obligate anaerobe, but source of culture is not specified.

Caduceus thermophilus a Prévot. (Annerobie thetmophilus a (Thermo a), Veilon, Ann. Inst. Past , 59, 1922, 428, Prévot, Ann Inst. Past , 61, 1933, 86; Bacillus thermophilus a Prévot, Man. d Class, etc., 1910, 150, Caduceus thermophilus Prévot, ibid, 149; Caduceus thetmophilus Prévot, ibid, 150) From horse maaure

Clostridium accticum Wieringa (Jour. Mierobiol and Serol, 6, 1930, 257.) From soil. Oxidizes II., using CO, as the hydrogen acceptor, forming acetic acid, thus using II. as sole source of

growth energy and CO2 as sole carbon source for cell growth.

Clostridium albo-lacteum Killian and Feher (Ann. Inst. Past., 55, 1935, 620) From Sahara Desert soil

Clostridium alboluteum Killian and Fehér. (Ann. Inst. Past., 55, 1935, 595) From Sahara Desert soil.

Clostridium album liquefaciens Killian and Fehör. (Ann. Inst Past., 55, 1935, 595) From Sahara Desert soil.

Clostridium album minor Killian and Fehér. (Ann. Inst. Past., 55, 1935, 620) Presumably identical with Clostridium minor Killian and Fehér. thid. 597.

From Sahara Desert soil
Clostridium album non liquefaciens
Killian and Fehér. (Ann. Inst. Past.,
55, 1935, 599) Presumably identical
with Clostridium non liquefaciens Killian
and Fehér, ibid, 597 From Sahara Desert soil

Clostridum americanum Pringsheim (Eine Alkoholo bildende Bakterienform, Pringsheim, Cent. f. Bakt., II Abt., 16, 1900, 200, Bacillus pringsheim Pringsheim, ibat., 311, Pringsheim, Cent. f. Bakt., II Abt., 16, 1900, 790; Clostridum butyricum var americanum Prévot, Man. d Class, etc., 1940, 199.) Anaerobie status uncertain. From spontaneously fermenting potato

Clostridium aurantibutyricum Hellinger (Commemorative Vol to Dr Ch. Weizmann's 70th Birthday, Nov., 1944, 46) From retted Hibiscus from So. Africa

Clostridum balaenas Prévot. (Walfischseptikämie Bacillus, Nielsen, Cent f. Bakt. 7, 1800, 269; Bacille de la septicémie des baleines, Christiansen, Compt. rend. Soc. Biol, Paris, 83, 1920, 324; Walfischseptikämiebazillus, Srinstiansen, Cent f. Bakt, I. Abt. Orig., 34, 1920, 127; Prévot., Ann. Inst. Past., 61, 1933, 81.1 From fiesh of whiles dying of septicemia Later isolated from same material by Christiansen.

Clostridium canadiense Dernby and Blanc. (Jour. Bact., 6, 1921, 420.) From a human case of gangrene.

Clostridium caproicum Prévot. (Ba-

cillus anaerobicus der Capronsäuregruppe, Rodella, Cent. f. Bakt., II Abt., fd, 1906, 58; Prévot, Ann. Inst. Past., 61, 1938, 84; Bacillus anaerobicus caproicus Prévot, Man. d. Class., etc., 1940, 140.) From cheese.

Clostridium cellobioparus Hungate. (Jour. Bact , 48, 1911, 499.) From rumen of cattle.

Clostridium cellulosae Horowitz-Wlassowa and Novotelnow. (Cent. f. Bakt., II Abt., 91, 1935, 477.) Cited only by name. Source not stated.

Clostridium corallinum Prévot and Raynaud. (Ann. Inst. Past., 70, 1944, 182) From serous fluid obtained post mortem from a mouse inoculated with an enulsion of street dust.

Clostridium cuniculi Galli. (Galli, Boll. Ist. Sieroter., Milan, 3, 1923-24, 337; Clostridium gallii Prévot, Ann. Inst. Past., 61, 1938, 83) From necrotic visceral lesion in a rabbit.

Clostridium disporum Vuillemin. (Compt. rend. Acad. Sci., Paris, 186, 1903, 1583.) Probably not anaerobic. Encountered in cultures of Blastomyces; said to form two spores.

Clostridium foetidum feeale Romanovitch. (Compt. rend. Soc. Biol., Paris, 71, 1911, 238.) From normal human intestine

Clostridium ghoni Prévot. (Unnamed species of Ghon and Mucha, Cent f. Bakt, I Abt, Ong, 39, 1905, 497; Prévot, Ann. Inst. Past, 61, 1938, 83.) From post-operative human peritonitis.

Clostridium giganteum Benecke and Keutner (Ber. d Deutsch. Botan Gesellsch., 21, 1903, 340.) From sea water. Clostridium haemolysans Hauduroy et

Markoff, Cent. f. Bakt., I Abt., Orig. 77, 1915-16, 421; Haudurcy et al, Dict d. Bact Path., 1937, 105; Plectralium hemolysans Prévot, Ann Inst Pat., 61, 1938, 87) From putrid human buccal tissues

Clostridum hueppei Trevisan. (Buttersaurebacilien, Hueppe, Mittell a d. kais Gesundhts, 2, 1884, 353; Bacillus butyricus Flugge, Die Mikroorg., 2 Auf., 1886, 300; Trevisan, I generi e le specie delle Batteriacee, 1859, 22; Bazillus pseudo-butyricus Kruse, in Flugge, Die Mikroorg., 3 Aufl., 2, 1896, 207; Bazillus hueppei Chester, Man. Determ. Bact., 1901, 276.) From milk.

Clostridium hyalinum Killian and Fehêr. (Ann. Inst. Past., 55, 1935, 595) From Sahara Desert soil.

Clostridium kluyseru Barker and Taha. (Jour. Bact., 43, 1042, 347.) From alcohol-containing enrichment celtures of Methanobacterium omclianskii inoculated with black mud from iresh water and marine sources.

Clostridum liborii Trevisan. (Liborius buttersăurebihidender Bacillus, Flugge, Die Mikroorg., 2 Aufi. 1886, 201 Trevisan, 1 generi e le specie delle Batteriacee, 1889, 22.) Presumably the same as Clostridium Joetidum Liborius, Ztechr. (1. Hyg., 1, 1886, 160. From mice inoculated with garden soil.

Clostridium medium Henneberg. (Cent. f. Bakt., II Abt, 55, 1922, 248) From human and animal feces.

Clostridium mitelmani Prévot. (Ann. Inst. Past., 61, 1938, 84) Stated by Prévot to have been isolated by Mitelman from diarrheal human intestine.

Clostridium mucosus Simola. (Simola. Ann. Acad. Scient. Fennicce, Relsink, Ser. A., 84, 1931, (115<sup>3</sup>); Clostridium mucosum Prévot, Man. d. Class., etc. 1940, 112; not Clostridium mucosum Berge et al., Manual, 4th ed., 1934, 472; quoted from Prévot, Ann. Inst. Past., 61, 1938, 80 who records it as a facultative manerobe.) Source of isolation unknown.

Clostridium myzogenes Simola. (Simola, Ann. Aead. Scient. Fennicoe, Heisinki, Ser. A, 34, 1933, (1157); quoted from Prévot, Ann. Inst. Past, 61, 1938, 80 who records it as a facultative 80 who records it as a facultative anaerobe) Source of isolation unknown.

Clostridium necrosans Prévot (Bacillus aerogenes necrosans Schupfer, Policim, Scz. Mcd, 12, 1903, 261; Prévot, Ann. Inst Past., 61, 1938, 84.) Isolated from a gaseous, necrotic thoracic abscess

Clostridium nothnageli Henneberg. (Cent. f. Bakt, II Abt, 55, 1921-22, 245) Cultivated, but not isolated in pure culture. from human and animal feces.

Clostridium partum Prévot. (Unnamed anaerobe of Levens, Cent. f Bakt, I Abt. Orig, 88, 1922, 479, Prévot, Ann. Inst Past., 61, 1938, 85.) From a cow in post-partum rausch-brand.

Clostridium propionicum Cardon and Barker. (Jour. Bact, 52, 1946, 629) From marine mud.

Clostridium proteolyticum Choukévitch. (Ann. Inst. Past., 27, 1913, 253) Said to be a facultative anaerobe From intesting of cattle.

Clostridium pygmaeum Henneberg. (Cent f Bakt, II Abt, 55, 1921-22, 250)

Clostridium sarcoemphysematodes Prévot (Bacillus sarcemphysematodes hominis Conradi and Bieling, Münch med Wochnacht, 63, 1916, 134, Clostridium sarcemphysematodes (sic) Prévot, Man Inst Past, 61, 1938, 81, Prévot, Man d Class, etc., 1940, 120) From human gascoug gangenee.

Clostridium sardiniensis Prévot. (Ann Inst. Past, 61, 1938, 81) Referred to Altara by Prévot. Cited by name only from Prévot.

Clostridium sectualum Hauduroy et al. (Unnamed species of Ghon and Sachs, Cent. f Bakt, I Abt, Orig. 48, 1909, 399; Hauduroy et al., Diet. d Bact Path, 1937, 1930) From human emphysematous liver.

Clostruium solutum Sanfelice. (Sanfelice, Zischr f. Hyg., 14, 1893, 372; Bacillus solutum Chester, Ann Rept Del Col Agr Erp Sta., 10, 1993, 129. Bacillus sonfelice: Migula, Syst d Bakt, 2, 1900, 630, not Bacillus solutus Ludersiz, Zischr f illyg., 6, 1890, 152) From putrefy ing meat infusions, soil and from animal exercise.

Clostridium sphaeroides Killian and Fehér (Ann Inst. Past , 55, 1935, 598) From Sahara Desert soil. Clostridium strasburgense Hauduroy et al. (Unnamed species of Vaucher, Boez, Lanzenberg and Kehlstadt, Bull. et Mem. Soc. Méd. Hôp Paris, 49, 1925, 1641; Hauduroy et al, Diet d. Bact. Path., 1937, 135, Inflabilis sanguacole Prévot, Ann Inst. Pat. 61, 1938, 77.) Isolated by blood culture in human puerperal serticemis.

Clostridium tenue Hauduroy et al (Bacullus anaerobicus tenuis Distaso, Cent. f. Bakt., I Abt., Orig., 62, 1912, 439; Bacullus anaerobius tenuis LeBlaye and Guggenbeim, Man. Prat. d. Diag. Bact., 1914, 337; Hauduroy et al., Diet. d. Bact. Path., 1937, 136) From normal humean intesting

Clostridium thermocadophilus Danon and Feirer. (Damon and Feirer, Jour. Bact., 10, 1925, 41; Palmula thermocadophila Prévot, Ann. Inst. Past., 61, 1938, 80, Acuforms thermocaidophilus Prévot, Man d. Class., etc., 1940, 165 Isolated anaerobically, but not strictly acceptible. Town horse manure.

Clostridium thermoaerogenes Damon and Feirer. (Damon and Feirer, Jour Bact, 10, 1925, 40, Caduceus thermoaerogenes Prévot, Ann Inst. Past., 61, 1938, 86) From house manure.

Clostridium thermocellum Viljoen, Fred and Peterson (Viljoen et al., Jour. Agric. Sci (London), 16, 1926, 7; Terminosporus thermocellus Prévot, Ann. Inst Past, 61, 1938, 86) From horse manure

Clostridium thermochainus Damon and Feirer. (Jour. Bact., 10, 1925, 42.) From horse manure

Clostridium thermophilum Jennel'jantschik and Borissowa (Microbiology (Russian), 10, 1911, 236-211; Bacillus thermophilus anaerobicus, idem; abst. in Cent f. Bakt., II Abt., 105, 1912, 143; not Clostridium thermophilum Pribram, Jour. Bact , 22, 1931, 430) From fish conserves

Clostridium thermoputrificum Damon and Feirer (Damon and Feirer, Jour Bact., 10, 1925, 39; Palmula thermoputrifica Prévot, Ann. Inst. Past., 61, 1938, 89; Acuformis thermoputrificus Prévot, Man. d. Class., etc., 1940, 165.)
From horse manure.

Clostridium toxinogenes Prévot. (Unnamed anaerobe of Kojima, Ztschr. f. Hyg., 99, 1923, 86; Prévot, Ann. Inst. Past., 61, 1938, 82) From muscle of a cow dying of symptomatic anthrax.

Clostridium ureolyticum Prévot. (Ann. Inst. Past., 61, 1938, 85; presumably Erde A, Geilinger, Cent. f. Bakt., II Abt., 47, 1917, 252.) From manured soil.

Clostridium calerianicum Prévot. (Făulnisanaerobien der Baldriansaure, Rodella, Cent. I. Bakt., II Abt., 16, 1995, 62; Prévot, Ann Inst. Past., 61, 1938, 84.) From cheese.

Clostridium viscosum Chudiakow. (Zur Lehre von der Anaerobiose, Teil I, 1890 (Russ.); quoted from Rothert, Cent. f. Bakt , II Abt., 4, 1898, 390.) A facultative anaerobe.

Clostridium zanthogenum DeGraaft. (Nederl. Tijd. Hyg, Microbiol. en Serol., 4, 1930, 219.) From cultured buttermilk undergong atypical fermentation

Clostridium zuntzii Henneberg. (Cent. f. Bakt., II Abt., 55, 1922, 249.) Cultivated, but not isolated in pure culture, from human and animal feces

Cornilia para Trevisan. (Bacillus liquefaciens pareus Luderitz, Ztschr. f. Hyg., 5, 1889, 148; Trevisan, I generi e le specio delle Batteriacee, 1889, 22; Bacterium pareum Migula, Syst. d. Bakt., 2, 1900, 324.) From animals inoculated with garden soil.

Endosporus otricolare Prévot. (Bacillo otricolare, Nacciarone, Riforma Med , Napoli, 55, 1917, 778, Prévot, Ann. Inst. Past., 61, 1938, 75.) From gangrenous war wounds

Granulobacillus sporogenes Andre. (Granulobacillus sp., Sommer, Deutsch. Monatschr. f. Zahnheilk., 33, 1915, 233, Andre, Ztschr. f. Hyg., 114, 1933, 412.) From infected, necrotic pulp of human teeth.

Granulobacter lactobutyricum Bei-

jerinck. (Ferment de lactate de chaux, Pasteur, Compt. rend. Acad. Sci., Paris, 86, 1853, 416; Beijerinck, Verhandl. d. k. Akademie v. Wetensch., Amsterdam, Tweedie Sectie, Deel J. 1893, 8; Bacillus lactabutyricus Migula, Syst. d. Bakt., £, 1900, 601; Amylobacter lactabutyricus van Beynum and Pette, Cent. f. Bakt., 11 Abt., 93, 1935, 200.) From fermenting grain mash and from soil.

Granulobacler pectinosorum Beijerinck and van Delden. (Plectridium pectinororum Stormer, Mitteil. d. deutsch. Landwirts. Gesellsch., 18, 1903, 195; Beijerinck and van Delden, Arch. Néerl. d. Sci. Exactes et Nat, Ser. II, 9, 1904, 423; Bacillus pectinororus LeBlaye and Guggenheim, Man. Prat. d. Diag Bact., 1914, 324; Bacillus pectnororum Henneberg, Cent. f. Bakt., II Abt., 55, 1922, 279; Clostridium pectinororum Donker, Thesis, Delft, 1926, 145 ) From retting plant tissues.

Granulobacter reptans Beijerinck and van Delden. (Cent. f. Bakt., II Abt., 9, 1902, 13.) Probably aerobic or microaerophilic. From garden and other soils.

Granulobacter sphaericum Beijerinck. (Cent. f. Bakt., II Abt., 7, 1901, 568) Probably aerobic or microaerophilic. From garden and other soils.

Granulobacter urocephalum Beijerinck and van Delden. (Arch. Néerl. d. Sci. Exactes et Nat., Ser. II, 9, 1904, 423) From retting plant tissues.

Hiblerillus rectus Heller. (Streptobacillus anaerobicus rectus Choukévitch, Ann. Inst. Past., 25. 1911, 350; Bacillus anaerobius rectus LeBlaye and Guggenheim, Man. Prat. d. Diag. Bact., 1914, 337; Heller, Jour. Bact., 7, 1922, 17; Inflabilis rectus Prévot, Ann. Inst. Past., 61, 1938, 77.) From large intestine of the horse.

Hiblerillus septimus Heller. (Art VII, von Hibler, Untersuch. 6. d. Path. Anser., 1908, 3 and 406; Heller, Jour. Bact. 7, 1922, 17; Clostridium septimum Prévot, Ann. Inst. Past., 61, 1938, 84.) From spleen of a guinea pig inoculated with soil. Inflabilis barati Prévot. (Bacille de Barat, Tissier, Compt. rend. Soc. Biol., Paris, 81, 1918, 426; Prévot, Ann. Inst. Part. 61, 1938, 77.). From beer wort

Inflabilis magnus Prévot. (Streptobouillus anaerobieus magnus Choukeviteh, Ann Inst. Past., 25, 1911, 251; Bacillus anaerobius magnus LeBlaye and Guggenheim, Man Prat. d. Diag. Bact., 1914, 337; Prévot, Ann Inst. Past. 671, 1938, 77.) From large intestine of the borse.

Inflatilis plagarum Prévot (Bacillus S, Adamson, Jour Path and Bact, 22, 1918-19, 373, Prévot, Ann Inst. Past, 61, 1938, 77) From war wounds.

Inflabilis pseudo-perfringens Prévot. (Presumably Bacillus L, Adamson, Jour-Path and Bact., 22, 1918-19, 372; Prévot, Ann Inst. Past., 61, 1933, 77) From yor wounds.

Inflabilis setiensis Prévot and Ray naud (Ann Inst Past, 70, 1914, 50) From oysters

Marteilillus proteolyticus Heller. (Organism II, Hempl, Jour. Hyg, 17, 1918, 16, Heller, Jour Bact., 7, 1922, 26.) From muscle in human gaseous gangrene.

Myerillus sadowa Heller. (Jour Bact, 7, 1922, 7, also Barney and Heller, Arch. Surg, 4, 1922, 477) From a gangrenous human arm

Pectinobacter amylophilum Makronov. (Arch Sci Biol. (Russ.), 18, 1915, 441.) Stated by author to be anaerobic, but description does not make this evident. From soil

Plectridum cellulolyticum Pochon (Compt. rend. Soc. Biol., Paris, 118, 1933, 1325.) Isolated anaerobically, but not strictly anaerobic. From stomach of ruminants

Pletridium pectinosorum liquefaciems Spolander and McCoy (Cent f. Bakt, II Abt., 97, 1937, 315 and 322, probably identical with Amylobacter liquefaciems Ruschmann and Bavendamm, Cent. f Bakt., II Abt. 64, 1937, 359) From spontaneously retting plant tissues

Plectridium anieszkos Prévot. (Unnamed anaerobic thermophilic cellulosefermenting species, Snieszko, Cent. f. Bakt, II Abt., 88, 1933, 403; Prévot, Man. d. Class, etc., 1940, 154.) From soil and manure.

Recordilus fragilis Heller. (Jour. Bact., 7, 1922, 8 and 27.) From a liver infarct in a cov.

Reglillus progrediens Heller. (Jour. Bact., 7, 1922, 7; also Barney and Heller, Arch Surg., 4, 1922, 477) From muscle of a sangrepous human arm

Robertsonillus primus Heller. (Organism I, Hempl, Jour Hyg, 17, 1918, 13; Heller, Jour. Bact, 7, 1922, 7) From a gangrenous war wound of human maxilla.

Streptobacillus terrae Ucke. (Cent, f. Bakt, I Abt., 25, 1898, 1000) From garden soil

Terminosporus raabi Prévot. (Unnamed anaerobe of Raab, Jour. Amer. Water Works Assoc., 10, 1923, 1051; Prévot, Ann. Inst Past., 81, 1938, 86) From Minneapolis city water.

Terminosporus thermocellulolyticus Pochon (Ann Inst Past., 68, 1942, 354, 383 and 467.) Strict anaerobo. Optimum growth at 60° to 66°C.

Tyrothrix catenula Duclaux. (Duclaux, Ann Inst. Nat. Agron., 4, 1882, 23; Cornilia catenula Trevisan, I generi e le specie delle Batteriacee, 1889, 22; Beatl-lus catenula Chester, Ann. Rept. Del Col Agr. Evp Sta., 10, 1898, 123.) Commonly regarded as anaerobic, but not by Migula (Syst. d. Bakt., £, 1900, 588). From cheese.

Tyrothriz clariformis Duclaux. (Du-chaux, Ann. Inst. Nat. Agron, 4, 1882, 23; Pacinia clariformis Trevisan, in Int., quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1839, 1017, Bacterium clariforme Migula, Syst. d. Bakt, 2, 1900, 322; Bacillus clariformis Vincent, Ann. Inst. Past., 21, 1907, 70.) From cheese.

Tyrothriz urocephalum Duclaux, (Duclaux, Ann. Inst. Nat. Agron., 4, 1882, 23, Bacterium urocephalum Chester, Ann. Rept. Del. Col. Agr. Exp. Sta., 10, 1898, 123; Bacillus urocephalum Migula, Syst. d. Bakt., 2, 1900, 538.)

Appendix II. The following organisms are listed in the text as probable syncnyms or possibly related species. They are cited here again in order to record the source of the original isolation. For convenience, they are listed alphabetically under the names of the species to which such presumed relationship is ascribed.

## I. Clostridium butyricum Prazmowski.

Amylobacter non liquefaciens Ruschmann and Bavendamm. From retting plant tissues.

Bacille amylozyme, Perdrix, From city water of Paris, and from the Seine River water.

Bacillus amylobacter S and W Wertbeim. From soil and tissues of field

Bacillus butylicus Fitz. From glycerol solutions undergoing butylic fermentation after inoculation with fresh cow feces.

Bacillus holobutyrıcus Perdrix putrefying milk.

Bacillus orthobutylicus Grimbert. From soil, grains and from legumes.

Bacillus saccharobuturicus von Klecki. From cheese.

Racterium nameula Reinke and Berthold. Observed and described from decomposing plant tissues Not isolated in pure culture

butyricum Chudiakow. Bactridium Cited by Rothert, and source not stated by abstractor

Butylbacıllus, Buchner From glycerinated hay infusion.

Clostridium butyricum (Bacillus amylobacter) I, II, III, Gruber From sugar solutions undergoing butyric fermentation. Source of inoculum not stated. (III is probably not strictly anaerobic ) iodophılum butyricum

Svartz. From human feces.

Clostridium

ıntermedium Donker. Clostridium From retting flax

Clostridium polyfermenticum Partansky and Henry From mud of streams and lakes and from soil

Clostridium saccharobutyricum Donker. From various farinaceous materials and from soil.

Clostridium saccharopetum Partansky and Henry. From mud of streams and lakes and from soil.

Clostridium saccharophilicum Partansky and Henry. From mud of streams and lakes and from soil.

Clostridium saccharopostulatum Partansky and Henry. From mudof streams and lakes and from soil.

Clostridium tyrobutyricum van Bevnum and Pette. From soil, water, milk, cheese and various farinaceous materials. Widely dispersed in nature

Ferment butyrique (Vibrion butyrique) Pasteur. Cultivated and presumably isolated from sugar solutions undergoing butyric fermentation after inoculation with yeast. Purity of cultures seriously questioned

Granulobacillus saccharobuturicus mobilis non-liquefactens Schattenfroh and Grassberger. From milk and from soil.

Granulobacter butylicum Beijerinck From fermenting grain mash and from soil.

Granulobacter saccharobutyricum Beiierinck. From fermenting grain mash and from soil.

Granulobacter saccharobutyricus immobile nonliquefaciens McCoy et al. Source of isolation not recorded.

Plectridium pectinovorum Stormer. From retting flax and hemp. Probably not strictly anaerobic

1b. Clostridium pasteurianium Winogradsky

Bacillus azotīcus, Bacillus dulcitofermentans, Bacillus inulofugus, Bacillus nonpentosus and Bacillus rhamnoticus Bodily. Source of isolation not specified, other than from cultures received from various sources labeled C. pasteurianum.

6 Clostridium septicum Ford. Bacillus tumefaciens Wilson! From human gaseous gangrene.

Bradsotbacillus, Nielsen From tissues and organs of sheep dying of bravy.

Walfischseptikämie Bacilius, Nielsen From whales evidently dead of septicemia resulting from harpoon wounds

## 9. Clostridium novyi Bergey et al Bacille neigeux, Jungano From a hu-

man case of fetid cystitis, from abscess of kidney, and from various perineal infections.

Bacıllus bellonensıs Sacquépée From human gaseous gangrene.

Bacillus gigas Zeissler and Rassfeld From tissues of a sheep dying of a braxylike disease

Bacillus oedematiens Weinberg and Seguin From human gaseous gangrene

Clostridium bubalorum Prévot. Isolated, but not named, by Kraneveld from cases of osteomyelitis of the East Indian

buffalo
Gavödembazilius, Aschoff. From human gaseous edema resulting from war
wounds.

11. Clostridium acetobutylicum McCoy

et al
Bacillus butylaceticum Freiberg From
grains, soil and natural waters Widely
distributed in nature

Bacillus butylicus B F, Ricard From drains from slaughter houses.

Hacillus saccharobutyricus liquefacens McCoy et al. Source of isolation unknown; records only from the collection of the Dept Agric. Bact of the Univ of Wis. Received from a commercial laboratory Rutulobacter betas Bakonys From

beets (Beta vulgaris) contaminated with soil.

Butylobacter sinense Bakonyi. From Jaffa oranges.

Butylobacter solani Bakonyi. From German potatoes.

Butylobacter zeae Bakonyı From Hungarian maize.

Clostridium butyricum (Prazmowski-Pike-Smyth) Pike and Smyth. From spontaneously fermenting corn meal mash. Clostridium inverto-acetobutylicum Legg and Stiles. From soil and from plant materials in contact with soil.

Clostridium propyl-butylicum Muller and Legg From soil and from plant materials in contact with soil.

Clostridium saccharo-acelobutylicum Stiles and Legg From soil and from plant materials in contact with soil,

Clostridium saccharo-acetobutylicumalpha McCov. From soil

Clostridium saccharo-acetobutylicumbeta Arzberger From soil, rotten wood,

grain, cornstalks and river mud Clostridium saccharo-acetobutylicumgamma Arzberger From soil, rotten

wood, grain, corn stalks and river mud Clostridium saccharobutyl-acetonicum Loughin From potato; found in soil and on plant materials grown in or near

Clostridium saccharobutylicum-gamma Izsak and Funk. From rice.

Clostridium saccharobutyl-isopropylacetonicum Loughlin. From potatoes, grains and other plant materials grown in or above soil.

Clostridium (Bacillus) tetrylium Owen, Mobley and Arroyo From soil and from roots of sugar cane.

Clostridium sporogenes Bergey et al

Bacillus putrificus terrucosus Zeissler. From animals suffering from a Rauschbrandlike infection, later from gan-

grenous war wounds

Bacillus saprogenes carnis Salus.

From human feces by enrichment in

meat mash medium

Bacillus sporogenes coagulans Debono

Empresental human intestina

From normal human intestine.

Paraplectrum foetidum Weigmann.

From cheese and milk
Reading Bacillus, Donaldson and Joyce.

From gangrenous human war wounds.

20 Clostridium bifermentans Bergey et al.

et al.

Bacillus centrosporogenes Hall. From
a sterility test of tuberculin, from canned

spinach and from garden soil.

Racillus liquefaciens magnus Lüderitz.
From mice and guinea pigs inoculated with garden soil

Bacillus nonfermentans Hall and Whitehead. From poisoned African arrowheads.

Bacillus oedemalis sporogenes Sordelli. From human enscous cangrene.

Bacillus putrificus tenuis Zeissler, From malignant edema of various animals and from human gascous gangrene.

Bacillus sporogenes foetidus Chaukévitch. From large intestine of horse.

Clostridium foetidum Liborius. From mice inoculated with garden soil.

Clostridium foetidum carnis Salus. From human feces by enrichment in meat mash medium.

Clostridium oedematoides Melency, Humphreys and Carp. From a case of human post-operative gaseous gangrene.

24. Clostridium perfringens Holland, Bacille du rhumatisme, Achalme. Isolated by blood culture from human cases of acute articular rheumatism.

Bacillus amylobacter immobilis Gratz and Vas. From Liptquer cheese.

Bacillus cadaveris Sternberg. From Liver and kidney of a yellow fever cadaver.

Bacillus cadaveris butyricus Buday From organs of human cadavers undergoing postmortem emphysema.

Bacillus egens Stoddard. From muscle in a fatal case of human gascous gangrone. Bacillus emphysematis maligni Wick-

lein. From human gaseous gangrene.

Bacillus emphysematis raginae Linden-

thal. From human kolpohyperplasia cystica or vaginitis emphysematosa. Bacillus multiformis Distaso. From

feces of dog.

Bacillus ovitoxicus Bennetts. From

blood, tissues and organs of sheep in Australia dying of entero-toxemia. Bacillus paludis McEwen. From intestines and viscera of sheep in the

Romney Marsh in England suffering from a disease called struck. Bacillus perfringens Veilion and Zuber.

Bacillus perfringens Veillon and Zuber. Originally isolated from pus in human appendicitis; later from a variety of sources.

Bacillus phlegmones emphysematosae Fraenkel. From human gaseous phlegmons; later from a variety of related conditions of human beings and animals.

Bacillus zoodysentriae hungaricus Detre. Isolated in Hungary from intestines of diarrheal pigs and lambs.

Clostridium perfringens var. anaerogenes Hauduroy et al. An unnamed culture isolated by Grooten by blood culture from a fatal human septicemia.

Granulobacillus saccharobutyricus immobilis liquefaciens Schattenfroh and Grassberger. Originally isolated from market milk; later from cheese, soil, water, human and animal feees, and from various train meals.

29. Clostridium paraputrificum Snyder.

Bacillus innutritus Kleinschmidt.

From stools of newborn infants.

Plectridium fluxum Prévot. From feces of nursing newborn infants.

Plectridium nonum Prévot. From emphysematous muscle of an amputâted human arm.

41. Clostridium lentoputrescens Hart sell and Rettger.

Bacillus cadaveris sporogenes (anaerobicus) Klein. From normal intestines of man and animals.

Bacillus radiatus Luderitz. From mice and guinea pigs ir culated with garden soil.

Bacillus tetanoides (B) Adamson. From human septic and gangrenous war

43. Clostridium tetanomorphum Bergey et al.

Bacillus fragilis Veillon and Zuber. From human cases of purulent appendi-

Bactllus ramosus Veillon and Zuber. From human cases of purulent appendicitis and from pulmonary gangrene

45. Clostridium angulosum Hauduroy et al.

Bacillus angulosus Garnier and Simon. From blood of a child suffering from typhoid fever.

61. Clostridium tertium Bergey et al. Bacillus aero-tertius Bulloch et al.

Isolated from gangrenous human war wounds. Stated to be aerobic. Becillus gazogenes parsus Choukévitch. From large intestine of horse. Racillus apermaide Ninni. From soil. SUBORDER II. CAULOBACTERIINEAE BREED, MURRAY, AND HITCHENS.\*

(Caulobacteriales Henrici and Johnson, Jour. Bact., 29, 1935, 3; ibid., 30, 1935, 83; Breed, Murray and Hitchens, Bact. Rev., 8, 1914, 255.)

Non-filamentous, attached bacteria growing characteristically upon stalks, sometimes sessile. The stalked cells are asymmetrical in that gum, ferric hydroride or other material is secreted from one side or one end of the cell to form the stalk. Multiply by transverse fission. In some species the stalks are very short or absent. In the latter case the cells may be attached directly to the substrate in a zoogloeic mass. Cells occur singly, in pairs or short chains, never in filaments; not ensheathed. Nonspore-forming. Typically aquatic in habitat.

## Key to the families of suborder Caulobacterlineae.

 Long axis of cell transverse to long axis of stalk; stalks dichotomously branched A. Stalks lohose, composed of gum, forming zoogloea-like colonies.

Family I. Nevskiaceae, p. 830.

B Stalks are bands of ferric hydroxide,

Family II. Gallionellaceae, p 830. II. Long axis of cell coincides with axis of stalk.

A. Reproducing by transverse fission, stalks unbranched.

Family III. Caulobacteriaceae, p. 832. III. Sessile, capsulated colonies of cocci and short rods attached to water plants. A. Deposit of ferric hydroxide about a zooglosic mass.

Family IV. Siderocapsaceae, p. 833

As a result of discussions that have taken place since the fifth edition of the Man-UAL was issued, certain readjustments have been made in the arrangement of the stalked bacteria. The organisms in all of the typical species are simple rigid bacteria which are like ordinary bacteria except that they develop a stalk. For this reason the group has been made a suborder of the order Eubacteriales.

Stanier and Van Niel (Jour Bact , 42, 1941, 454) emphasize the fact that the family Pasteuriaceae includes species which reproduce by methods (longitudinal fission, budding) different from those found in other groups of bacteria, and Henrici and Johnson (loc. cit., 81) state that it is at least doubtful whether these species are phylogenetically related to the other stalked bacteria. While waiting for pure culture studies and a clarification of these relationships, this family has been placed in an appendix to the suborder Caulobacterineae.

The family Siderocapsaceae has been included in the suborder as the absence of a stalk in attached forms is a natural modification. As stated by Cholodny (Die Eisenbakterien, Jena, 1926, 34-58), these bacteria are similar in morphology and physiology to those found in the family Gallionellaceae. This is an arrangement that retains all of the simple non-filamentous types of iron bacteria in one general

group.

The stalked bacteria studied by Henrici and Johnson (loc. cit.) were of fresh water origin. Bacteria of this type are found, however, equally if not more abundantly in marine habitats where they play their part in starting the fouling of underwater surfaces. ZoBell and Upham (Bull. Scripps Inst. Oceanography, La Jolla, Cali-

<sup>\*</sup> Completely revised by Prof. A. T. Henrici, University of Minnesota, Minneap olis, Minnesota, December, 1938; further revision by Prof. Robert S. Breed, New York State Experiment Station, Geneva, New York, July, 1916

fornia, 5, 1944, 253) summarize this situation as follows: "Many of the bacteria found in sea water are sessile or periphytic, growing preferentially or evclusively attached to solid surfaces. The sessels habit of marine bacteria is most pronounced when they are growing in very dilute nutrient solutions such as sea water to which nothing has been added ... Most sessile bacteria appear to attach themselves tenaciously to solid surfaces by evuding a mucilaginous holdfast A few have stalks. Some of the sessile bacteria grow on the walls of the culture receptacle without clouding the mailing intentity"

The emphasis placed on the presence of a stalk by Henrici and Johnson ((cc. ct.) seems artificial In fact it may be questioned whether mere attachment by a hold-fast or otherwise is a character of fundamental importance from the taxonome standpoint. Henrici and Johnson's arrangement of these poorly known bacteria, however, has certain practical advantages and it has therefore been retained in this edition of the Manual with such modifications as seem to be clearly indicated by the progress that has been made since their outline was multished

The submerged elide technique as employed by Henrici (Jour Bact., 25, 1933, 277) and by ZoBell and Allen (Proc. Soc Exper Bol. and Med., 29, 1933, 1909) has proved to be most useful for studying bacteria that live attached to a substrate.

# FAMILY I. NEVSKIACEAE HENRICI AND JOHNSON.

(Jour. Bact., 29, 1935, 4; ibid., 50, 1935, 83.)

Stalked bacteria, the long axis of the rod-shaped cells being set at right angles to the axis of the stalk. Stalks lobose, dichotomously branched, composed of gum. Multiplication of cells by transverse binary fission. Growing in zoogloca-like masses in water or in sugar yats.

There is a single genus Nevskia.

### Genus I. Nevskia Faminizin.

(Bul. Acad. Imp. Sci., St. Pétersb., 54, N.S. 2, 1892, 484.) From the Neva River at St. Petersburg.

Description as for the family.

The type species is Nevskia ramosa Famintzin.

 Nevskia ramosa Famintzin (Bul. Acad. Imp. Sci., St. Pétersb., Ser. IV, 54, N.S. 2, 1892, 484.)
 From Latin ramosus. branched.

Globular, bush-like or plate-like colonies of gummy consistency floating upon the surface of water Colonies composed of gummy material arranged in dichotomously branched stalks arising from a common base, with the bacterial cells contained in the gum, a single cell at the tip of each stalk. At times cells are set free from the stalks to start new colonies.

Rod-shaped cells set with their long axis at right angles to the axis of the broad lobe-like stalk Cells 2 by 6 to 12 microns, containing a number of highly refractile globules of fat or sulfur

Multiplication by binary fission Not cultivated on artificial media

Source: From the aquarium in the Botanical Garden, St. Petersburg. Similar but smaller organisms found by Henrici and Johnson (Jour. Bact., 50, 1935, 63) in a jar of water from the lily pond of the University of Minnesota greenhouse in Minneapolis

Habitat: Water.

Nevskia pediculata (Koch and Hosacus) Henrici and Johnson. (Bacterium pediculatum Koch and Hosacus, Cent. f. Bakt., 16, 1894, 225; Henrici and Johnson, Jour. Bact., 30, 1935, 83)
 From Latin pediculus, diminutive of pes, foot.

Composed of twisted, short, thick, sausage-like strands, often branched These strands are stalks, composed of zum.

The cells occur at the tips of the stalks and are smaller than those of Nerskia ramosa and are without internal globules. Not cultivated.

This organism is very similar to, and may be identical with, the cultivated species described and named Betabacterium vermiforms by Mayer (Das Thi-Konsortium. Thesis, Utrecht, 1938). See p. 362.

Source Found growing in the syrup of a sugar refinery as zoogloeae.

# FAMILY II. GALLIONELLACEAE HENRICI AND JOHNSON.

# (Jour. Bact., 29, 1935, 4; ibid., 50, 1935, 83.)

Stalked bacteria, the long axis of the rod-shaped cells being set at right angles to the axis of the stalks. Stalks are slender, twisted bands, dichotomously branched, composed of ferric hydroxide, completely dissolving in dilute hydroxloric scid. Multiplication of cells by transverse binary fission. Grow in iron-bearing waters.

There is a single genus Gallionella

### Genus I. Gallionella Ehrenhera.

(Ehrenberg, Die Infusionsthierehen, 1833, 165; not Gaillonella Bory de St. Vincent, Dict. Classique d'Hist. Nat., 4, 1823, 393, Glescula Kutring, Phycologia Generalis, 1813, 245; Didymoheliz Griffith, Ann. Mag. Nat. Hist., Ser. 2, 12, 1853, 433; Spiraphyllum Ellis, Cent. f Bakt. II Abt., 19, 1907, 502, Nodofolium Ellis, Proc. Rov. Soc. Edimburgh, 28, Part 5, 1908, 333) From an incorrect spelling of the algai genus name. Gailbenella.

Description as for the family.

The type species is Gallionella ferruginea Ehrenberg.

#### Key to the species of cenus Gallionella.

I. Cells kidney-shaped, stalks branched

A. Stalks slender, spirally twisted

1. Cells small, stalks very slender.

1. Gallionella ferruginea.

2. Cells larger, stalks broader.

Gallionella major.
 B. Stalks thick, not definitely in spirals.
 Gallionella minor.

II. Cells oval or round: stalks unbranched.

4. Gallionella corneola.

1. Gallionella ferruginea Ehrenberg (Gaillanella ferruginea Ehrenberg, Vorl Mittheil, u. d. wirkl, Vorkommenn fossiler Infusionen u ihre grosse Verbreitung. Ann Phys., Ser. 2, 8, 1836, 217, Ehrenberg, Die Infusionsthierchen, 1838, 163, Melosira ochracea Ralfa, Ann and Mag Nat. His., Ser. 1, 12, 1843, 351 (quoted from Buchanan, General Systematic Bacteriology, 1925, 363); Glocotila ferruginea Kützing, Species Algarum, 1849, 363, Dilymohelix ferruginea Griffith, Ann Mag. Nat Hist , Ser 2, 12, 1853, 438; Glososphaera ferruginia Rabenhorst, Alg. Mitteleur, no 397, Hedwigia, 8, no. 9, 1854, 43, Melosira minutula Breb . Alg Fal., 5, 42 (quoted from DeTons and Trevisan, see below), Spirulina ferruginea Kirchner, Algen, Kryptogamenflora v. Schlesien, 2, 1, 1878, 250, Spirochaete ferruginea Hansgirg, Oestr. botan Ztschr , no. 7-8, 1883, 5, Spirillun ferrugineum DeTons and Trevisan, in Saccardo, Sylloge Fungarum, 8, 1889, 1037; Chlamydothrix ferruginea Migula, Syst. d Bakt., 2, 190), 1031, Spirophyllum ferrugineum Ellis, Cent. f Bakt.,

II Abt, 19, 1907, 502, Spirəphyllum tenue, Notafolium ferruyineum, Spirosoma ferruyineum and Spirosoma solenade Ellis, Proc Roy Soc. Edinburgh, 32, Part 5, 1908, 311, 430 see Cent, f. Bakt, II Abt, 28, 1910, 321; Gallionella tacanata Enderleid, Bakterien-Cyclogenue, Berlin and Leping, 122, 282)

From Lvtan ferreginus, iron rust.
Kidney shaped bacteria, the cells 0.5
by 12 microns, which secrete colloidal
ferrie hydroxide from the concave portion of the cell, forming band-like stulks.
A rotatory motion of the cells gives rise
to a spiral twistum of the stalks.

In the older studies, the stalks were described as the organism, the minute cells at the tip having been dislodged or at least overlooked. The cells lie at the tip of the stalks, and multiply by transverse buarry fission. This gives rise to a dichotomous branching of the stalks Stalks become very long and slender, with smooth edges

Not cultivated in artificial media. Habitat: Cool springs and brooks which carry reduced iron in solution.  Gallionella major Cholodny. (Trav. Station biolog. du Dniepre Acad. des Sci. de l'Ukraine, Classe Sci. Phys. et Math., 5, Livre 4, 1927.) From Latin major, larger.

Very similar to Gallionella ferruginea, but the cells are distinctly larger (1 by 3 micross), and, some cells failing to divide, reach a length of 7 micross or more. These form stalks of double the normal width.

The cells contain one or more vacuoles, apparently filled with an iron compound. Source: Found in a spring in the Cau-

Habitat · Iron-bearing water

3 Gallionella minor Cholodny (Ber. d. deutsch Bot. Ges, 42, 1921, 35.) From Latin minor, smaller.

Cells as in Gallionella ferruginea, but stalks are shorter, thicker, encrusted with nodules of iron and not definitely band-like or twisted.

Habitat · Iron-bearing water.

4. Gallionella corneola Dorff. (Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 25) From Latin corneolus, a little horn. Cells spherical or ellipsoidal, or lenticular in cross section, 0.5 by 2.5 to 3.0 microns.

Stalks short, unbranched, not spirally twisted, completely dissolving in dilute hydrochloric acid. Stalks slender at the base, expanded at the tip, slightly curved, 15 to 30 microns long, attached to the substrate by a holdfast, 3 to 8 stalks arising from a single holdfast.

Habitat: Iron-bearing water.

Appendix: Additional species of Gallionella have been described as follons: Gallionella glomerala described by Naumann (Kungl Svenska Vetenskapsakad. Handl., I. 62, 1921, Part 4, 43) is not a valid species according to Cholodny (Die Eisenbakterien, Jens, 1926, 40). From the Aneboda region, Swedn

40). From the Aneboda region, Sweden Gallionella reticulosa Butkevich. (Ber. d. Wiss. Meeresinst. Moscow, 3, 1928, 58 and 60). From the White See

58 and 80.) From the White Sea. Gallionella sideropous described by Naumann (Kungl. Svenska Vetenskapsakad. Handl., I, 62, 1921, Part 4, 33 is not a valid species, according to Cholodny (Die Eisenbakterien, Jena, 1926, 39). From the Aneboda region, Sweden. Gallionella lortuosa Butkevich. (Ber.

Gallionella tortuosa Butkevich. (Ber. d wiss. Meeresinst. Moscow, 5, 1928. 57 and 79.) From the Petschora Sca.

# FAMILY III CAULOBACTERIACEAE HENRICI AND JOHNSON.

(Jour. Bact., 29, 1935, 4; ibid., 30, 1935, 83.)

Stalked bact
of the stalks.

button-like

" a long sus strate by se binary

a button-like fission The outermost cell of a pair may form a stalk beture cen union is complete. Periphytic, growing upon submerged surfaces.

There is a single genus Caulobacter

# Genus I. Caulobacter Henrici and Johnson.

(Jour. Bact , 29, 1935, 4; tbid., 30, 1935, 83) From Latin caulis, stalk and bacter, a small rod

Description as for the family.

The type species is Caulobacter vibrioides Henrici and Johnson.

 Caulobacter vibrioides Henrici and Johnson (Jour. Bact., 30, 1935, 84.)
 From Latin, like a vibrio Cells elongated, curved, vibrio-like, with rounded ends, 97 to 12 by 20 to 2.5 microns

Growing upon firm substrates in water Not cultivated on entificial - di-

Hobitat. Water

Appendix: Henrici and Johnson (Jour Bact . 50. 1935. 62) list the following as nossibly belonging in this genus

Racillus flagellatus Omeliansky (Jour. Microbiol (Russian), 1 1914, 21) Probably the same as the organism described by Jones (Henries and Johnson loc cit., 62).

Polar flagellate organism. Jones. (Cent. f. Bakt., II Abt., 14, 1905, 459.) From water and sawage

Vahriothrix tonsullaris Tunnichff and Jackson. (Tunnicliff and Jackson, Jour. Inf Dis . 46, 1930, 12; see Henrici and Johnson, loc cit, 62) From tonsil crypts See p. 219 for a different view. point regarding this species

Six additional types are figured but not named by Henrici and Johnson (loc ct . 84).

#### FAMILY IV SIDEROCAPSACEAE PRIBRAM

(Tribe Siderocansege Buchanan, Jour. Bact . 2, 1915, 615, Pribram, Jour. Bact 18, 1929, 377.)

Cells spherical or ovoid. Motile stages, if any, unknown. Not yet cultivated on artificial media. Thick capsules enclosing the cells become encrusted with ferric hydroxide Attached to the surface of leaves and other parts of water plants.

Ken to the genera of family Siderocapsaceae.

I. Cocci, occurring singly and in groups, and embedded in small irregular gelatinous merane

Genus I. Siderocansa, n. 833.

II. Coccobacteria, occurring in chains, and embedded in large gelatinous masses. Genus II Sideromonas, n. 831.

#### Genus I Siderocapsa Molisch.

(Ann. Jard. Bot. Buitenzorg, 2 Sér., Supp. 3, 1909, 29; also Die Eisenbakterien. Jena, 1910, 11.) From Greek sideros, iron and Latin capsa, box.

One to many spherical to ovoid small cells embedded in a mass of capsular material surrounded by ferric hydroxide. Best recognized by staining with Schiff's reagent Motility unknown Grow attached to the surface of water plants.

The type species is Siderocapsa treubs: Molisch.

1 Siderocapsa treubți Molisch (Ann Jard Bot Bustenzorg, 2 Sér . Supp 3, 1909, 29; also Die Eisenbakterien, Jena, 1910, 11 ) Named for Prof Treub, the director of the tropical garden at Bustenzorg, Java.

Cocci. 04 to 06 micron in diameter embedded in zoorlocal masses surrounded by ferric hydroxide.

Deposit ferric hydroxide on the surfaces of water plants.

Source: Found attached to the roots, root hairs and leaves of water plants

(Elodea, Numphaea, Samttaria, Salmina

Habitat, Widely distributed, on fresh water plants

2. Siderocapsa major Molisch (Ann. Jard Bot. Bustenzorg, 2 Sér., Supp. 3, 1909, 29; also Die Eisenbakterien, Jena. 1910, 13) From Latin major, larger

Cells colorless, coccus-like short rods. 0 7 by 1.8 microns. A colony consists of 2 to 100 or more cells.

Similar to Siderocapsa treubis, except

that the cells are larger and the gelatinous capsule is less sharply defined,

Source: Isolated from Spirogyra sp. Habitat: Epinhytic on fresh water plants.

Appendix: Two additional species have been placed in the genus Siderocansa by later investigators:

Siderocansa coronata Redinger. (Arch. f. Hydrobiol., 22, 1931, 410.)

From lake water. A free floating form. Siderocansa manaica (Kuncl. Svenska Vetenskapsakad. Handl., I, 62, 1921, Part 4, 49; quoted from Cholodny, Die Eisenbakterien. Jena, 1926, 59.) Found on Potamogston natans in Sweden. Cells occur singly.

### Genus II. Sideromonas Cholodny.

(Ber. d. deutsch. Bot. Ges., 40, 1922, 326; also Die Eisenbakterien, Jena. 1926, 55) From Greek sideros, iron and monas, a unit.

Small cocci or coccobacteria which grow in chains in gelatinous masses containing ferric hydrovide attached to thread algae, generally of the genus Conferra.

The type species is Sideromonas confervarum Cholodny.

I. Sideromonas confervarum Chalodny. (Ber. d. deutsch. Bot. Ges., 40. 1922, 326; also Die Eisenbakterien, Jena, 1926. 55: Siderocystis confervarum Naumann, quoted from Dorff, Die Eisenorganismen. Pflanzenforschung, Heft 18. 1934, 13.) From Latin, of the genus Conferva.

Coccobacteria: 0.5 to 0.6 by 0.8 to 0.9 micron, occurring in chains embedded in gelatinous masses, 10 to 100 microns in diameter. Chains become visible when the gelatinous mass is treated with formalin followed by drinte HCl, washed in water, and stained with gentian violet or carbol fuchsin. No mounty observed.

Form deposits of ferric hydroxide in the gelatinous mass surrounding the bacteria.

Source: Found on the surface of thread alone in water containing iron salts.

Habitat: Widely distributed on fresh water green algae

Appendix: Additional species of simple, sessile, non-filamentous bacteria which cause deposits of ferric hydroxide have been described. The majority are rod-shaped bacteria and resemble Sideromonas. The list follows: Brussoff.

Ferribacterium colceum

(Brussoff, Cent. f. Bakt., II Abt., 48, 1918. 208: Siderobacter calceum Naumann, Svenska Vetenskansakad. Handl., I, 62, Part 4, 1921, 53 and 63; Bacillus calceus De Rossi, Microbiol. Agraria e Technica, Torino, 1927, 903 ) From slime in drainage ditches at Aschen.

Ferribacterium duplex Brussoff. (Brussoff, Cent. f. Bakt., II Abt., 45, 1916, 517; Sideroderma duplex Naumann, Svenska Vetenskapsakad. Kungl. Handl., I, 62, Part 4, 1921, 53 and 63; Bacterium duplex De Rossi, Microbiol. Agraria e Technica, Torino, 1927, 903) A non-motile, diplobacterium from water samples from Breslau (Schwentniger and Pirschamer).

Naumanniella minor Dorff. Pflanzenforschung, Eisenorganismen, Heft 16, 1934, 21.) From iron-bearing spring water at Worms (Rhein).

Naumanniella neustonica Dorff. (Die Eisenorganismen. Pflanzenforschung, Heft 16, 1934, 2J) From Neuston on Tuefelsee near Freienwalde. Dorff (loc. cit.) indicates this species as the type for a new genus Naumanniella.

Naumann. Siderobacter duplex Vetenskapsakad Svenska Handl., I, 62, Part 4, 1921, 55) From Aneboda region, Sweden.

Siderobacter lineare Naumann (loc est., 55). From Aneboda region, Sweden. The type species of the genus Siderobacter.

Sidercevecus communis Dorff (Die Eisenorganismen, Pflanzenforschung, Heft 16, 1931, 11.) Widely distributed in Germany, Finland, Russia, Sweden, Czechoslovakia and the U.S. A

Siderococcus limoniticus Dorff (loc cil.). From a swamp iron ore deposit This is the type species of the genus Siderococcus Dorff (loc cit.).

Siderocystis duplex Naumann (Kungl. Svenska Vetenskapsakad Handl, I, 62, Part 4, 1921, 43) From Aneboda region, Saeden.

Siderocystis minor Naumann (loc. cit,
43). From Aneboda region, Sweden.
Siderocystis vulgaris Naumann (loc
cit, 42). From Aneboda region, Sweden

The type species of the genus Siderocystis

Sideroderma limnelicum Naumann. (Kungl. Svenska Vetenskapsakad. Handl., I, 62, Part 4, 1921, 32; Ochrobium tectum Perfiliev, Verh. d Internat. Vereinigung f. theoret. u angew. Limnologue, 1925, Stuttgart, 1927; quoted from Dorff, Die Eisenorgausmen, Pflanzenforschung, Heft 16, 1934, 18) From Ancboda region, Sweden The type species of the genus Suderoderma. Perfiliev regards this species as type for a new genus. Ochrobium.

Sideroderma rectangulare Naumann (loc. cit, 54) From Aneboda region, Sweden

Sideroderma tenue Naumann (loc. cit., 51). From Aneboda region, Sweden.

Siderothece major Naumann. (Kungl. Svenska Vetenskapsakad. Handl., I, 62, Part 4, 1921, 17) From Aneboda region, Sneden. The type species of the genus Siderothece.

Siderothece minor Naumann (loc. cit., 17) From Aneboda region, Sweden.

# APPENDIX TO SUBORDER CAULOBACTERINEAE.

The family Pasteuriaceae included among the stalked bacteria by Henrici and Johnson (loc cit.) has been placed in this appendix as the organisms belonging to the genera Pasteuria and Blastocaults reproduce by methods of fission or budding, or both, that are different from the methods of reproduction found in other bacteria. Further information regarding the organisms in these genera is greatly needed

FAMILY A PASTEURIACEAE LAURENT EMEND, HENRICI AND JOHNSON.

(Laurent, Compt rend. Acad. Sci., Paris, 3, 1890, 751; Henrici and Johnson, Jour. Bact , 30, 1935, 81)

Stalked bacteria with spherical or pear-shaped cells; if cells are elongated, long axis of cell coincides with axis of stalk. Stalks may be very short or absent, but when present are usually very fine and at times arranged in whorls attached to a common holdfast. Cells multiply by longitudinal fission or by budding, or by both Mostly periphytic, one species is parasitic.

Key to the genera of family Pasteurlaceae.

I Stalks lacking, cells sessile.

Genus I. Pasteuria, p. 836.

Il Stalks long and slender, often in whorls.

Genus II. Blastocaulis, p. 836.

### Genus I. Pasteuria Metchnikoff.

(Ann Inst Past , 2, 1888, 166 ) Named for Louis Pasteur, the French chemist and bacteriologist.

Pear-shaped cells attached to each other or to a firm substrate by holdings secreted at the narrow end, multiplying by longitudinal fission and by budding of spherical or ovoid cells at the free end

The type species is Pasteuria ramosa Metchnikoff.

I Pasteuria ramosa Metchnikoff (Ann. Inst. Past , 2, 1888, 465.) From Latin ramosus, branched

Cells grow attached to each other in cauliflower-like masses, multiplying by longitudinal fission and by intracellular spores (?) which are extruded as bud-like bodies.

Habitat: Parasitic in the body cavities of Daphnia pulex and Daphnia magna.

#### Blastocaulis Henrici and Johnson. Genus II

(Jour. Bact , 30, 1935, S1 ) From Greek blastos, bud, germ and Latin caults, stalk. Pear-shaped or globular cells attached to a firm substrate by long slender stalks with a holdfast at the base. Stalks may occur singly or may arise in clusters from a common holdfast. Growing on firm substrates in fresh water. Not cultivated on

artificial media The type species is Blastocaulis sphaerica Henrici and Johnson.

 Blastocaulis sphaerica Henrici and Johnson (Jour. Bact , 30, 1935, 84) From Latin sphaera, sphere

Cells spherical, multiplying character-

istically by budding, often staining deeply at the free pole and faintly at the attached pole, I to 2 microns in diameter.

Habitat, Water.

Appendix: Henrici and Johnson (loc. cst., S4) figure but do not name four additional types of these organisms which they regard as additional species belonging to this genus.

Stanier and Van Niel (Jour. Bact , 42, 1941, 454) regard the following as be-

longing to this group:

Hyphomicrobium vulgare Stutzer and Hartleb (Saltpeterpilz, Stutzer and Hartleb, Cent. f. Bakt., II Abt., 3, 1897, 621; Stutzer and Hartleb, Untersuchungen uber die bei der Bildung von Saltpeter beobsehieten Mikroorganismen, I Abt. Mittheil landwirtech Inst Univ Breslau, 1898, abst in Cent f Bakt., II Abt. 5, 1899, 678)

From tap water and soil. The position of this organism in relation to other Schizomyceles is very uncertain. It is regarded by Boltjes (Arch f Mikrobiol . 7, 1936, 188) as an organism which may be transitional between Schizomycetes and Phycomycetes The cells possess structures which appear to be polar flagella, but with dark field illumination show an attached thread of ultramicroscopic size Reproduction by cell division was not observed Possibly this may be by budding from the attached Associated with Natrobacter thread spp. This is the type species of the genus Hyphomicrobium Stutzer and Hartleb

# SUBDRICK III. RHODOBACTERIINEAE BREED, MURRAY AND HITCHENS.\*

(Family Rhodobacteriaceae Migula, Syst. d. Bakt., 2, 1900, 1042; Breed, Murray and Hitchens. Bact. Rev., 8, 1944, 257.)

Cells spherical, rod., vibrio., or spiral-shaped. Size of individual cells from less than 1 to over 20 microns. Motility, when exhibited, due to the presence of polar flagella. Gram-negative so far as known. No endespores formed. Red, purple, brown or green bacteria which contain bacteriochlorophyll or other chlorophyll.

of extraneous oxidizable compounds which are dehydrogenated with the simultaneous reduction of carbon dioxide. As axidizable substrates a variety of simple substances can be used, such as sulfide, or other reduced sulfur compounds, molecular hydrogen, alcohols, fatty acids, hydrovy- and keto-acids, etc. All can be grown in strictly macrobic cultures when illuminated. Those members which can grow in the presence of air can also be cultured in the dark under serobic conditions. Color depends markedly on environmental conditions; small individuals appear colorless unless observed in masses. May contain sulfur globules. Described species have largely been found in fresh water habitats. Some species occur in marine habitats.

#### Key to the families of suborder Rhodobacterlineae.

- Purple bacteria whose pigment system consists of bacteriochlorophyll and various carotenoids capable of carrying out a photosynthetic metabolism.
  - A. Contain sulfur globules in the presence of hydrogen sulfide. The sulfur purple bacteria

Family I 'Thiorhodaceae, p. 841.

- B. Do not contain sulfur globules even in the presence of hydrogen sulfide. All require organic growth factors. The non-sulfur purple and brown bacteria - Pamily II. Alhiorhodaccae, p. 861.
- II. Green sulfur bacteria containing a pigment system which has the characteristics of a chlorophyllous compound although it differs from the chlorophyll of green plants and from the bacteriochlorophyll of the purple bacteria.

Family III. Chlorobacteriaceae, p 869.

The organisms previously included in the order Thiobacteriales Buchanan do not constitute a taxonomic entity; they represent rather a physiological-ecological community. In this sense, however, a special treatment of this group as a unit has decided advantages from a determinative point of view.

When first proposed as a systematic assemblage, the order Thiobacteria Migula (Syst. d. Bakt., 2, 1900, 1037) was intended to include the morphologically conspicuous organisms which, in their natural habitat, contain globules of sulfur as sell inclusions. Since Winogradsky (Betr. r. Morph. n. Physiol. d. Bact., I, Schwefelbacterien, 1833 had elucidated the function of hydrogen aulfide and of sulfur in their metabolism, the characteristic inclusions appeared linked with a hitherto unrecognized type of physiology, viz. the oxidation of an inorganic substance instead of the decomposition of organic materials. From this oxidation the sulfur bacteria derive their energy for maintenance and growth.

Completely revised by Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

Two groups of sulfur bacteria could be distinguished, one consisting of colorless. the other of red or purple organisms. The members of both groups presented an unusual morphology apart from the sulfur droplets; in all cases the individual cells were considerably larger than those of the common bacteria, while many species grew as distinctive colonial aggregates. Migula separated these sulfur bacteria into two families, Begggatogceae and Rhodobacteriaceae. Even at that time, however, some difficulties existed as to just what organisms should properly be considered as sulfur bacteria. Miyoshi (Jour. Coll Sci., Imp. Univ., Tokyo, 10, 1897, 143) had discovered a bacterium which forms stringers, incrusted with sulfur, in sulfur springs. but which does not store sulfur globules in its cells Although physiologically this Organism appeared to comply with Winogradsky's concept of a sulfur bacterium, the absence of the typical cell inclusions made Miyoshi decide it could not be considered as such. The problem was aggravated when Nathansohn, Benerinck, and Jacobsen published their studies on small, colorless, Pseudomonas-like bacteria capable of exidizing hydrogen sulfide, sulfur, and thiosulfate, and evidently dependent upon this exidation process for their development. Morphologically these organisms have little in common with the Beggiatoaceae, they were designated by Beijerinck as species of Thiobacillus and have since been rightly considered as members of the order Eubacteriales (see p 78). Nevertheless, these organisms are physiologically in no way different from the Beggggtogceae, so that if physiology only is considered, a good case could be made out for their incorporation in the Thiobacteriales,

Furthermore, Molisch (Die Purpurhakterien, Jena, 1907, 95 pp) described in some detail a number of bacterial species which, in view of their characteristic pigment system, appeared closely related to the Rhodobacteriaceae, but which develop only in organic media and are, therefore, not sulfur bacteria in the senge of Winogradsky or Migula. In a treesing the importance of pigmentation Molisch combined the resulfur bacteria and the newly discovered purple bacteria into an order Rhodobacteria with the two families Thiorhodaceae and Athiorhodaceae. It is this grouping that has been followed in the present edition of the Manual.

Only a very small number of typical sulfur bacteria have been studied in pure cultures. As a result the descriptions of genera and species rest mainly on observations made with collections from natural sources or crude cultures. Most investigators have implicitly accepted differences in cell size or in colonial appearance as a sufficient justification for establishing independent species. Evidently this proce-

bacterin have established beyond a doubt that environmental conditions, such as composition of the medium and temperature, may evert a profound influence on the general morphology of these organisms. By this, it is not intended to infer that the previously proposed genera and species of sulfur bacteria should be abandoned. But it does follow that a cautious evaluation of the distinguishing features is necessary. In the absence of catefully conducted in estigations on morphological constancy and variability of most of the previously recognized species of sulfur bacteria with pure cultures grown under a variety of external conditions, the best approach appears to be a tentative arrangement of these organisms based upon those characteristics which are readily ascertainable. Urperience with this group over the past twenty years has shown that, while Winogradsky's fundamental work must remain the foundation of present taxonomic efforts, it is advasable to simplify the much more claborate classification developed by Buchanan which was followed in previous editions of this Manual.

Certain genera of sulfur purple bacteria, created by Winogradsky, will very probably be consolidated when detailed information concerning the morphology of the organisms is available. Until such time it seems, however, best to retain most of them, even though the distinguishing characteristics are not always very clear. For the benefit of those who are familiar with previous methods of classification it will be indicated where deviations have been adorted.

The non-sulfur purple bacteria (Athiorhodaceae Molisch, Rhodobacteriodace Buchanan) have been subjected to a comparative morphological and physiological study comprising more than 150 strains, among which all previously proposed genera and species are represented (Yan Niel, Bact. Rev., 8, 1944, 1-118). It has been found that the characteristics upon which Molisch based the seven genera of this group are inadequate, and a new classification with only two distinguishable genera has been proposed. This system will be followed here.

nego. ulfur

compounds other than sulfides. They are photosynthetic and are capable of growing in anaerobic culture when illuminated. The green pigment differs from the green plant chlorophylls and from the bacteriochlorophyll of the purple bacteria, but has the characteristics of a chlorophyllous compound. These are grouped in the family Chlorobacteriactae.

#### FAMILY I THIORHODACEAE MOLISCH

(Molisch, Die Purpurbakterien, Jena, 1907, 27; Subfamily Chromatioideae Buchanan, Jour. Bact., 3, 1918, 461; Rhodo-Thiebacteria Bavendamm, Die farbiosen und roten Schwefelbacterien, Pflanzenforschung, Heft 2, 1924, 102; Rhodothiebacteria Bavendamm, Ergeb Biol, 15, 1936, 49)

Unicellular organisms, often developing as cell aggregates or families of variable size and shape Single cells have the form of spheres, ovoids, short rods, vubrios, spirals, long rods or, occasionally, chains. They occur in nature in environments containing sulfides and require light for their development, infra-red irradiation of awave-length extending to about 000 millimerons is effective. They produce a prement system composed of green bacteriochlorophyll, and yellow and red carotenoids. As a result they appear as pale purple, broanish to deep red cell masses. Single cells, unless they are of considerable size, usually appear to be unprigmented. These are anaerobic or microaerophilic organisms, with a photosynthetic metabolism in which carbon diovide is reduced with the said of special hydrogen donors without the liberation of molecular oxygen. Where these organisms are found in nature, hydrogen sulfide acts as a hydrogen donor, and sulfur, the first intermediate oxidation product, accumulates as sulfur droplets in the cells. Probably all members of the group can utilize a number of organic substances other than hydrogen sulfide as hydrogen donors for rabiotsynthesis. Thus they are potentially murotrophic.

Characterization of the genera in this group has since Winogradsky's studies (Beitrage zur Morphologie und Physiologie der Schwefelbsterien, Leipzig, 1883) been based upon the mode of development of the cell aggregates Pure culture studies (Bavendamin, Die farblosen und roten Bakterien, I Schwefelbakterien, Pfanzenforschung, Heft 2, 1924, 74 pp. van Niel, Arch f. Mikrobiol., 5, 1931, 1-112, Manten, Antonie van Leeuwenhoek, 8, 1942, 164 pp.) have since shown that not only the sequence of events in the formation of the sigregates but also the appearance and form of the latter even including the size and shape of the component cells are influenced to a considerable extent by environmental conditions. This obviously casts doubt upon the usefulness of the previously used diagnostic enterna for genera and species. On the other hand, the scope of pure culture studies has not yet attained sufficient breadth to warrant the use of a different approach. As a provisional measure, Winogradsky's genera are therefore maintained. Even the larger taxonomic units must be regarded as being of tentative value only

### Key to the genera of the family Thiorhodaceae.

- I. Cells usually combined into aggregates
  - A Cells grouped as regular sarcina packets
    - Genus I Thiosarcina, p 842
  - B. Cells not in sarcins packets
    - 1 Aggregates in the form of a flat sheet
      - a. Cells in regular arrangement, with tetrads as the common structural unit
        - Genus II Thiopedia, p 843
      - aa. Cells in irregular aggregates.
        - Genus III Thiocapsa, p 511.

Appendix: The following genus was formerly placed near Thiopedia. Winogradsky, Migula, E. F. Smith and others disregard this genus A record is included here because of its historic interest.

## Genus A. Lampropedia Schroeter.

(Schroeter, in Cohn, Kryptog, Flora v. Schlesien, 3, 1, 1886, 151.) From Greek lampros, bright and pedion, plane,

Trevisan (I generi e le specie delle Batteriacee, 1889, 28) and DeToni and Trevisan (in Saccardo, Sylloge Fungorum, 8, 1889, 1048) list as synonyms: Erythroconis Oersted, Naturhistorisk Tidsskrift, 2, 1810, 555; in part, Pediococcus Lindner, Ingue Diss., Berlin, 1887, 97: Thiopedia Winogradsky, Schwefelbacterien, Leipzig, 1883, 85

Cells united into tetrads, forming flat, tubular masses, contain sulfur globales and bacteriochlorophyll and yellow and red carotenoids.

The type species is Lampropedia hyalina (Chrenberg) Schroeter.

- 1. Lampropodia hyalina (Ehrenberg) Schroeter. (Gonium hyalinum Ehrenberg, Abhandl. d Berl, Akad., 1830; Merismopedia hyaling Kützing, Species Algarum, 1819; Sarcina hyalina Winter, in Rabenborst, Kryptogamen-Flora, 2 Aufl., 1, 1851, 51: Schroeter, in Cohn. Kryptogram. Flora v. Schlesien, S. 1, 1886, 151; Pediococcus hyalinus Trevisan. I generi e le specie delle Batteriacee, 1889. 28: Microcoecus hyalinus Migula, Syst d. Bakt , 2, 1900, 195.) From swamp water and decomposing materials from sugar refineries.
- Lampropedia reitenbachii (Caspary) DeToni and Trevisan (Merismopedium reitenbachii Caspary, Schriften d physik, okon Gesellsch, zu Königsberg, 15. 1874. 101: Sarcina reifenbachti Winter, in Rabenhorst, Kryptogamen-Flora, 2 Aufl., 1. 1884, 50; Pediococcus reichenbacher (ste) Trevisan. I generi e le specie delle Batteriacee, 1889, 28; DeToni and

Trevisan, in Saccardo, Sylloge Fungorum. 8. 1889, 1018.) Found on rotting water-plants.

- 3. Lampropedia violacea (Breb.) De-Toni and Trevisan. (Agmenellum violaceum Breb., quoted from DeTon and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1049; Merismopedia violacea Kutzing, Species Algarum, 1819, 472; Pediacoccus violaceus Trevisan, I generi e le specie delle Batteriaces, 1889, 28; DeToni and Trevisan, loc. cit., 1048) From stagnant water. Common.
- 4. Lampropedia ochracea (Mettenhermer) DeToni and Trevisan. (Merismopedia ochracea Mettenheimer, Abhandl, d. Senkemberg naturforsch. Gesellsch. in Frankf., 2, 1856-58, 41; DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1949.) From the yellowish slime from a well at I rankfurt.

# Genus III Thiocapsa Winogradsky.

(Schwelelbacterien, Leipzig, 1888, 81) From Greek theion, sulfur and Latin capsa, container, capsule.

Cells spherical, occurring in families of irregularly arranged individuals held together in a common slime capsule The aggregates are spread out flat on the sub-As the colony grows, the capsule bursts, and the strate " -- -- similar cells are sp bacterioto that in

chlorophyll and carotenoid pigments, capatio ... hydrogen sulfide Under such conditions sulfur is stored in the form of globules in the cells. This genus is so much like Thiothece that it is doubtful whether a distinction can be maintained.

The type species is Thiocapsa roseopersicina Winogradsky.

### Key to the species of genus Thiocapsa.

- I Individual cells about 3 microns in diameter.
- 1 Thiocapsa roseopersicina
- II Individual cells about 15 microns in diameter.
  - Thiocapsa floridana.

was first found.

Arch. f Hydrobiol , 18, 1927, 84; Thio-

capsa minima Issatchenko, Borodin Ju-

bilee Volume, p. 6, 1929? ) From the

locality, Florida, where the organism

in diameter. In groups of irregular

colonies, each surrounded by a common

capsule, several colonies being stuck

Source: Palm Springs, Florida and

Habitat · Mud and stagnant water con-

Lake Salskoje, near Eupatoria, Crimea.

taining hydrogen sulfide and exposed to

light, sulfur springs Probably ubiqui-

Illustration. Uphof, loc. cit. 83.

together Motility not observed.

Cells Spherical About 15 microns

1 Thiocapsa roseopersicina Winogradsky (Schwefelbacterien, Leinzig, 1888. 84) From Latin roseus, rose-colored and persicum, peach, M.L., peachcolored

Cells. Spherical, 25 to 3 microns in diameter, occurring in families of irregularly arranged individuals held together in a common slime cansule Motility not observed. Usually a distinct rose red Stored sulfur droplets may attain a considerable size

Habitat Mud and stagnant bodies of water containing hydrogen sulfide and exposed to light, sulfur springs

Illustration Winogradsky, loc cit, Plate IV, fig 15

2. Thiocapsa floridana Uphof (Uphof, Genus IV. Thiodictyon Winogradsky.

fig VI.

(Winogradsky, Schwefelbacterien, Leipzig, 1888, 80, Rhododictyon Orla-Jensen. Cent. f. Bakt , II Abt , 22, 1909, 334 ) From Greek theron, sulfur and dictyon. net.

Cells rod-shaped, frequently with pointed ends, somewhat resembling spindles. Form aggregates in which the cells become arranged end to end in a net-like structure, somewhat reminiscent of the shape of the green alga Hydrodictyon The shape is not constant, cells may also form more compact masses Sometimes groups of cells separate from the main aggregate by active movements Common gelatinous capsule not observed Contain bacteriochlorophyll and carotenoid pigments; cells usually very faintly colored Capable of photosynthesis in the presence of hydrogen sulfide; the cells then store sulfur as small globules

The type species is Thiodictyon elegans Winogradsky

1 Thiodictyon elegans Winogradsky (Winogradsky, Schnefelbacterien, Leipzig, 1888, 80; Thiodictyon minus Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, 251) From Latin elegans, tasteful, elegant. Rods. 1.5 to 1.7 by 2 5 to 5 microns, or

longer just prior to cell division. Usually contain a large pseudovacuole (aerosome), leaving a rather thin protoplasmic shorth along the cell wall.

Sulfur droplets Generally quite small, and deposited exclusively in the thin protoplasmie laver.

Issatchenko (Études microbiologiques des Lacs de Bouc, Leningrad, 1927, 113-114) recognices a forma minus and a forma magna, differentiated mainly by the size of the individual rods.

Habitat: Mud and stagnant water, containing hydrogen sulfide, and exposed to light; sulfur springs.

Mustrations: Winogradsky, loc. cit., Plate III, fig. 13-17.

# Genus V. Thiothece Winogradsky.

(Winogradsky, Schwefelbacterien, Leipzig, 1833, 82; Thiosphaera Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170.) From Greek theion, sulfur and theke, container.

Purple sulfur bacteria which, in their growth characteristics, resemble the bluegreen alga Aphanolhece. Cells spherical to relatively long cylindrical-ellipsoidal, embedded in a gelatinous capsule of considerable dimensions. Following cell division the daughter cells continue to secrete mucus which causes the individual ba-

the cells.

The type species is Thiothece gelatinosa Winogradsky.

 Thiothece gelatinosa Winogradsky, (Winogradsky, Schwefelbacterien, Leipzig, 1888, 82; Thiosphaera gelatinosa Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170; Lamprocystis gelatinosa Migula, Syst. d. Bskt., 2, 1900, 1014; Chromatium sphaeroids. Hama, Jour. Sci. Hiroshima Univ., Ser. B., Div. 2, Bot., 1, 1933, 158.) From Latin gelatio, freezing, indicating solidification or chumping.

Cells: 4 to 6 by 4 to 7 microns, spherical

to cylindrical. Color of individual cells, faint, often grayish-violet, or even dirty yellowish. Sulfur globules usually deposited in outermost layers of protoplasm, and generally small.

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs.

Illustrations. Winogradsky, loc. cit., Pl. III, fig. 9-12; Miyoshi, loc. cit., Pl. XIV, fig. 25.

# Genus VI. Thiocystis Winogradsky.

(Schwefelbacterien, Leipzig, 1888, 60.) From Greek theion, sulfur and kystis, sac,

often diplococcus shaped. Colonies may emerge a substitute of the common capsule and break up afterwards, sometimes into single swarmers, or the aggregates may split up inside the original capsule, and release small motife units or single swarmers. In pure cultures frequently developing as single cells and diplococci. Produce bacteriochlorophyll and carotenoid pigments, coloring the cell masses purplish to red. Capable of photosynthess in the presence of hydrogen aulfide, whereby elementary sulfur is formed as an intermediate oxidation product which is deposited as droplets inside the cells.

The type species is Thiocystis violacea Winogradsky.

#### Key to the species of genus Thiocystis.

- Individual cells more than 2 microns in width.
- Thiocystis violacea.
   II Individual cells about 1 micron or less in width.
- 2 Theorystis rufa.

1 Thiocystis violacea Winogradsky (Winogradsky, Schwfelbacterne, Leipzig, 1888, 65, Planosarcina violacea Migula, in Engler and Prantl, Die naturl Pflanzenfamilien, I, 1s, 1895, 20) From Latin violaceus, violet-colored

Cells. About 25 to 55 microns in diameter, spherical to ovoid Swarmers actively motile by means of polar flagella

Colonies Small, maide a common capsule, containing not over 30 cells Several such colonies form loosely arranged aggregates, most characteristically composed of about 10 to 20 colonies in a single capsule. The result is a nearly spherical zoogloea. In small colonies, the cells appear as rather distinct tetrads, in larger colonies, the cells become somewhat compressed and the tetrad-like arrangement may be lost.

In pure cultures, the species often fails to produce the characteristic capsules, the organisms then occur as actively motile single cells or diplococci, with little or no slime formation No pseudocapsules are formed

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs.

Illustrations: Zopf, Zur Morphologie der Spaltpflanzen, Leipzig, 1882, Pl. V, fig. 12, Winogradsky, loc. cit, Pl. II, Fig. 1-7.

Thiocystis rufa Winogradsky.
 (Schwefelbacterien, Leipzig, 1888, 65)
 From Latin rufus, red.
 Cells Less than 1 micron in diameter.

Cells Less than I micron in diameter. Color red, usually darker than in the type species When the cells are stuffed with sulfur globules, the aggregates appear almost black

The common gelatinous capsule usually contains a far greater number of closely packed individual colonies than is the case in Throcystis violacea

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs

Illustration: Winogradsky, loc. cit., Pl II, fig 8.

### Genus VII. Lamprocystis Schroeter.

(In part, Clathrocystis Cohn, Bestr Baol. Pfl., 1, Heft 3, 1875, 188; in part, Cohnia

Lilis, Sulphur Bacteria, London and New York, 1932, 135) From Greek lampros, bright, shining, and kystis, sac cr bladder

Purple sulfur bacteria which form more or less large aggregates of cells enclosed in a common gelatinous capsule. Individual cells spherical to ovoid. Small aggregates closely resemble those of Thiocystis, even to the extent of the tetrad-like arrangement of cells in the small colonies. Behavior of the large aggregates during development appears to be different; the small individual cell groups or colonies do not emerge from the sime capsule until the initially relatively compact cell mass becomes broken up into smaller clusters, these eventually forming a somewhat net-

like structure. This behavior has been ascribed to a change in the mode of cell division which at first appears to take place in three perpendicular planes, and later presumably changes to a division in only two directions. Cells when free are motile by means of polar flagells. In pure culture also this type rarely, if ever, produces large aggregates with the development here mentioned as characteristic for the genus (Bavendamın, Die farblosen und roten Schwefelbakternen, Pflanenforschung, Hett 2, 1924, 76). This, along with the other similarities, makes it doubtful whether future studies will result in the retention of the genera Lamprocystis and Thiospisis side by side. Produce bacteriochlorophyll and carotenicl pigments, coloring the cell masses purplish-pink to red. Capable of photosynthesis in the presence of hydrogen salified, storing elementary sulfur as globules inside the cells

The type species is Lamprocystis rescopersicina (Kutzing) Schroeter,

 Lamprocystis roseopersicina (Kützing) Schroeter. (Microlog rosea Kutzing, Linnaes, 8, 1833, 371; Cruptococcus roseus Kutzing, Phycologia generalis. Leipzig, 1843, 149; Protococcus roseopersicinus Kutzing, Species Algarum, Leipzig, 1849, 196; Palmella persicina Cohn, Leonhard's Jarbb f. Mineralog., 1864, 606; Pleurococcus roseo-persicinus Rabenhorst. Flora Eur Leipzig, 3, 1868, 28; Bacterium rubescens Lankester, Quart Rev Micro. Sci., 18. 1873. 40S: not Bacterium rubescens Chester, Ann. Rept Del. Col. Agr Exp. Sta., 9, 1897, 115; Clathrocystis roseopersicina Cohn, Beitr Biol. Pfl , 1, Heft 3, 1875, 157; Cohnia roseo-persicina Winter, in Rabenhorst, Kryptogamen Flora, 2 Aufl , 1, 1884, 48; Schroeter, in Cohn, Kryptogamen-Flora von Schlesien, 3, 1, 1886, 151, Planosarcina roseo-persicina Migula, in Engler and Prantl, Die natürlichen Pflanzenfam., I, la, 1895, 20; Lankasteron rubescens Ellis, Sulphur Bacteria, London and New York, 1932,

135.) From Latin roseus, rose-colored and persicum, peach; M.L., peach-colored.

In all probability, Thioderma rubrum Miyoshi (Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 170) is identical with this species.

Cells: Spherical to ovoid, 2 to 2.5 mierons in diameter, up to 5 microns long before cell division. Motile. Polar flagellate.

Winogradsky (loc. cit.) reports that the cells frequently contain pseudovacuoles Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs

Rlustrations. Warming, Videnakab. Meddel. naturhistor. Foren., Kjöbenhavn, 1876, Pl VIII, fig. 3 g; Zopl, Z Morphol d. Spattpflannen, Leiptig, 1852, Pl. V, fig. 8, 13; Winogradsky, Schnefebacterien, Leipzig, 1838, Pl. II, fig. 9-15; Bavendamm, Die farblosen und roten Schweielbakterien, Jena, 1924, Pl II, fig. 3-2.

# Genus VIII. Amoebobacter Winogradsky

Leipzig, 1888, 71; Amoebomonas Orla-Jensen, From amoeba, one of the protozoa character, and Greek baktron, rod.

Purple sulfur bacteria, usually occurring in aggregates composed of many individuals without a characteristic common capsule. Slime formation can, nevertheless, be observed with very small colonies. With growth of the individual cells, the capsule bursts and the cell mass slowly moves out while the bacteria remain unitedthe colonies change their shape during growth and in response to environmental influences; the individual cells appear motile and cause the movements of the entire colony. Winogradsky ascribes the coherence of the cell masses to the existence of interconnecting protoplasmic filaments between cells, but these have never been observed, and their occurrence is extremely doubtful. It is much more probably that the bacteria are held together by mucus, though not so much of the latter is produced as to form a clearly disseruible cansule.

Produce bacteriochlorophyll and carotenoid pigments. Capable of photosynthesis in the presence of hydrogen sulfide, and then store sulfur as droplets inside the cells

The type species is Amoebobacter roseus Winogradsky.

Since the characterization of the genera Amochociter, Lemprocystis, Thicogustis Thicogras and Thiothere is based upon the arrangement of individual bacteris in a common capsule, which, from Winogradsky's descriptions of Amochobacter and from pure culture studies with Thicogstis and Lamprocystis, has been shown to vary considerably, depending upon developmental stages and environmental conditions, it is quite possible that future investigations will show the desirability of restricting the number of genera

#### Key to the species of genus Amoebobacter.

- 1 Cells apherical to ovoid, about 2 5 to 3 5 microns in diameter and up to 6 microns in length prior to cell division.
- 1 Amoebobacter roseus
  II Cells distinctly rod-shaped, about 15 to 2 microns in width by 2 to 4 microns
- in length

  2 Amoebabacter bacillosus.
  - 2 Amoebobacter bacillosus.
- III Cells spherical, quite small, about 0 5 to 1 micron in diameter
  - 3. Amochobacter granula.
- 1. Amoebobacter roseus Winogradsky (Schwefelbacterien, Leipzig, 1888, 77) From Latin roseus, rose.

Cells sphereal to ovoid, 25 to 35 microns in width and up to 6 microns in length. Mothe Often contain pseudovacuoles. Cell-aggregates often form transitory hollow spheres or sacks, with the bacteria occupying the periphery as achallow layer These are reminiscent of stages in the development of Lamprocentis.

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs,

Hustrations. Winogradsky, toe ett., Pl. III. fig 1-6.

2 Amoebobacter bacillosus Winogradsky. (Winogradsky, Schwefelbacterien, Leipzig, 1888, 78; Thioderma roseum Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 158) From Latin bacillus, resembling a rod.

Cells rod-shaped, about 1.5 to 2 microns by 2 to 4 microns Cells contain seedovacuoles (acrosomes). Sulfur globules deposited exclusively in peripheral protoplasme layer, usually quite

Habitat Mud and stagnant water, containing hydrogen sulfide and exposed to light; sulfur springs

Illustrations Zopf, Z. Morphol. d Spaltpfl., Leipzig, 1882, Pl. V, fig. 26-27; Winogradsky, loc cit., Pl. III, fig. 7.

Myoshi's incomplete description of Thiodirma rosium (i.e. cit), type species of genus Thiodirma, is sufficient to make practically certain that it is identical with Imoebebrater bacillosus. The description of Thiodiction elegant Winogradsky (loc cit) suggests that it cannot be distinguished from this species. Amoebobacter granula Winogradsky.
 (Schwefelbacterien, Leipzig, 1888, 78.)
 From Latin granulus, a granule.

Cells: Spherical, small, about 0.5 to 1 micron in diameter. Faint pigmentation; the sulfur inclusions give the cell masses a black appearance. Aggregates are up to consist of closely-knit masses which are difficult to separate.

When sulfur is stored, a single droplet

usually fills most of the cell Because of the high refractive index of this globule, it becomes difficult if not impossible to make accurate observations of the cell shape.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs.

Illustration: Winogradsky, loc cit., Pl. III. fig. 8.

### Genus IX. Thiopolycoccus Winogradsky.

(Winogradsky, Schwefelbacterien, Leipzig, 1883, 78; Rhodopolycoccus Orla-Jensen, Cent. f. Bakt., II Abt., 22, 1909, 334.) From Greek theion, sullur; polyn, many; and kolkos, granulo or small cell.

Purple sulfur bacteria a hich form dense aggregates of rather solid construction and irregular shape. The colonics appear, in contrast with Amoebobacter, non motite and do not tend to form holiow rooglocal structures by which they are differentiated from Lamprocystis. Cell masses held together by mucus which does not, however, appear as a regular capsule. Large clumps may fissure with the formation of irregular shreds and lobes which continue to break up into smaller groups of cells Individual bacteria spherical, motility not observed. Contain bactericahorophylia and carotenoid pigments, so that the aggregates, in accord with the dense packing with individual cells, appear distinctly red. Capable of photosynthesis in the presence of hydrogen sulfide, when the cells store elementary sulfur as droplets inside the cells.

The type species is Thiopolycoccus ruber Winogradsky.

Thtopolycoccus ruber Winogradsky.
 Kinogradsky, Schwefelbacternen, Leipzig, 1888, 79; Micrococcus ruber Migula, in Engler and Prantl, Die natürlichen Pflanzenfamilien, I, In, 1895, 18) From Latin ruber, red.

Cells. Spherical, about 12 microns in diameter. No motility observed. Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to hight, sulfur springs.

Illustrations: Winogradsky, loc. et., Pl. IV, fig 16-18; Jssatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig. 7.

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# Genus X. Thiospitllium Winogradsky.

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u teenn hisaooge, baktenen, Jena, 1924, 115.) From Greek theson, sultur, and ununuant

Purple sulfur bacteria, occurring singly, as spirally wound cells, motile by means of noiar flagella Contain bacteriochlorophyll and carotenoid pigments, coloring of noiar flagella Contain bacteriochlorophyll and nhotosynthesis in the presence of

The differentiation of species in this gloup and -

tions with material from natural collections and from laboratory mass cultures. The criteria used are the size and shape of the spirals, and the color of the organisms Not a single representative has so far been obtained and studied in pure culture, so that no information is available concerning the constancy or variability of these characteristics. It is, however, likely that such properties may be greatly influenced by environmental factors. Hence, the following key and descriptions of species are apt to be modified when more extensive studies have been made. The published descriptions of some species make it seem probable that they should not even be incorporated in Thomacultum.

The type species is Thiospirillum genense (Ehrenberg) Winogradsky

#### Key to the species of genus Thiospirillum.

- I. Width of cells 2.5 microns or more
  - 1. Color of cells, especially in masses, yellowish-brown to orange-brown
    - 1. Thiospirillum jenense.
  - 2 Color of cells deep red or violet
    - a. Cells long, typical spirals, clearly red

      2 Thiospirillum sanguineum
    - aa. Cells short, slightly curved, vibrio-shaped, color purple to violet-red
- II. Width of cells less than 2.5 microns.
  - 1. Width of cells 1.5 to 2 5 microns.
    - 4 Thiospirillum rosenbergii
    - 2 Width of cells about 1 micron
- 5 Thiospirillum rufum
- 1. Thiospirillum jenense (Ehrenberg) Winogradsky (Ophidomonas genensis Ehrenberg, Die Influsionstiereiben, Leipzig, 1838, 44, Spirillum jenense Trevisan, Batter, ital, 1879, 26, Winogradsky, Schwefelbacterien, Leipzig, 1888, 104, Modolkhospirillum jenense This, Sulphur Bacteris, London and New York, 1932, 161, Thiospirillum crassum Hama, Jour. Sei. Hiroshima Univ., Ser B, Div. 2, Bet., 1, 1933, 157) Named for the city of Jena, Germany, where Ehrenberg discovered this organism.
- Cells Cylindrical, sometimes puinted at ends, 2 5 to 4 microns long, coiled as spirals Generally 30 to 40 microns in length but may be as long as 100 microns. Shape of individual coils varies, complete turns measuring about 15 to 40 microns in length, and from 1 to 1/10 of the width in height. Polar flagellate Tutfed at both ends Olive-brown, sepia brown and reddib-brown.

This coloring appears to be the only recognizable difference from Thiospirilium crassum Hama (loc cit) reported to be 37 to 4 by 12 to 40 microns and yellowishbrown in color, thus becomes indistinguishable from Thiospirilium jenens; the 80 microns long Thiospirilium jenens forma maxima Szafer (Bull Acad Sec Cracovic, See B, 1910, 162) does not at present justify recognition as a special taxonomic entity

It is even doubtful whether the observed color difference between Thiospiritum penense and Thiospiritum anguineum constitutes a valid criterion for their maintenance as two distinct species (Buder, Jahrb. wiss Bot, 56, 1915, 531, Bavendamm, Die farblosen und roten Schwefelbakterien, Pflanzenforschung, 1162, 21931, 313

Habitat. Mud and stagnant water containing hydrogen sulfide and exposed to light, more rarely in sulfur springs. Illustrations: Zettnow, Ztschr. I. Hyg., 24, 1897, Pl. 1I, fig. 49-52; Buder, loc. ctt., fig. 1; Szafer, loc. cit., Pl. IV, fig. 4; Hama, loc. cit., Pl. 18, fig. 1, 8a; Pl. 19, fig. 1.

2. Thiospirillum sanguineum (Ehrenberg) Winogradsky. (Ophidomonas sanguinea Ehrenberg, Verhandt. Akad. Wiss. Berlin, 1810, 201; Spirillum sanguineum Cohn, Beitr. Biol. Ph., 1, Heft 3, 1875, 169; Winogradsky, Schwefelbacterien, Leipzig, 1888, 1604. From Latin zanguneus, blood-colored, red.

Cells: Cylnadrical, sometimes attenuated at ends, spirally coiled; 2.5 to 4.0 microns in width, commonly about 40 microns long with a range of from 10 to 100 microns. Size and shape of coils variable, complete turns measuring from 15 to 40 microns in length and from 4 to 1/10 of the length in width. Polar flagellate, usually tutted at both ends. Individual cells rose-red with a grayish hue, groups of cells deep red. Sulfur droplets numerous under appropriate conditions.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light, rarely in sulfur springs.

Hustrations Cohn, loc. ctt, Pl. VI, fig 15, Warming, Vidensk Meddel, naturhist. Foren, Kjöbenhavn, 1876, Pl. VII, fig 8, Buder, Jahrb wiss Bot, 56, 1015, 534, fig. 2

3 Thiospirilium violaceum (Warming) Winogradsky (Spirilium violaceum Warming, Vidensk Meddel. naturhist. Foren, Kjobenhavn, 1876, 305; Winogradsky, Schwefelbacterien, Leipzig, 1888, 104) From Latin relaceus, violetcolored.

Cells Short and fat, 3 to 4 by 8 to 10 merons, ends smoothly rounded. Slightly curved, bean- or vibrio-shaped Only rarely are they twisted suggesting a spirillum. Polarly flagellated.

The shape of cell seems to fit the genus Chromatium rather than Thiospirillum and Warming (loc. cit.) emphasizes the resemblance to Chromatium okenii.

Color bluish-violet; this color may be related to a scarcity of sulfur droplets in the cells.

Habitat: Mud and stagmant water. Hustration: Warming, loc. cit., Pl. VII, fig. 3.

 Thiospirillum rosenbergii (Warning) Winogradsky. (Spirillum rosenbergii Warning, Vidensk. Meddel. naturhist. Foren., Kjöbenhavn, 1876, 316; Winogradsky, Schwefelbacterien, Leipzig, 1888, 104.) Named for the Danish algologist, Rosenberg.

Cells: 1.5 to 2.5 by 4 to 12 microns; coiled, with turns of about 6 to 7 8 microns in length and variable width up to 3 or 4 microns. Color very dark, due to numerous sulfur globules. Color of protoplasm not recorded.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light.

Distribution: Probably ubiquitous, but less frequently recorded as the organism is not as spectacular as the large Thiospirillum penense and Thiospirillum sanguineum.

Illustration: Warming, loc. ctt., Pl. X, fig. 12.

5. Thiospicillum trium (Perty) Migula. (Spirillum rufum Perty, Bera, 1852, 179; Migula, Syst d. Bakt. 2, 1900, 105)) From Latin rufus, red, reddish. General characteristics presumably those of the genus, although it does not appear either from Perty's description, or from those of Migula (loc. cit.), Bavendamm (Die farblosen und roten S-haefelbakterien Jena, 1924, 132) and Huber-Pestalozzi (Die Binnengen ässer, 16, Heft 1, Das Phytoplankton des Süsswassers, Stuttgart, 1938, 334) that the cells ever contain sulfur globules. Only the red color is emphasized Conscquently, it is quite possible that this organism belongs in the genus Rhodo-

Cells: 1.0 by 8 to 18 microns; coiled to occupy 13 to 4 turns, the latter commonly 4 microns wide by 4 microns long. These dimensions agree with those of Rhodospirillum rubrum (Esmarch) Molisch and the identity of the two organisms is

Habitat: Found in red slime spots on the side of a well. Mud and stagnant hading of water.

Illustration. Migula, Syst d Bakt, 1, 1897, Pl III, fig 7

Appendix: Three species have been placed in the genus Thiospirillum without convincing evidence that they conform to the generic diagnosis

Thiospirillum agilis Kolkwitz (Kolkwitz, Kryptogamenslors d. Mark Brandenburg, 5, Pilze, 1909, 162, Thiospira agilis Bayendamm. Die farblosen und roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 116.) This is not known to have been a purple bacterium and hence may represent a member of the gapus Thisanira

Thiospirillum agilis var. polonica Strzeszewski. (Bull. Acad Sci., Cracovie, Sér. B, 1913, 322.) This also may belong in the geous Thiospira

Thiospirillum pistense Czurda. (Cent f Bakt, II Abt, 22, 1935, 409) Not described as pigmented and does not contain sulfur globules. Reported to be a probable agent in the production of hydrogen sulfide from sulfates or sulfur It may therefore be the spirillar form of Vibro desulfurcans Beliginch, or, being thermophilic, of Vibrio thermo-devellurcans Elion.

Thiospirillum winogradshii Onielianshy (Cent f. Bakt, II Abt, 14, 1905, 761.) This is colorless and is included in Thiospira

#### Genus XI. Rhabdomonas Cohn .

(Cohn, Beitr Biol Pfl., 1, Heft 3, 1875, 167; Mantegazzaea Trevisan, R. Inst. Lombardo de Sci e Lett., IV, Ser 2, 12, 1879, 137; Rhabdochromatium Winogradsky, Schwefelbacterien, Leipzig, 1883, 109, 11 patt, Rhodocapaa Molisch, Die Purpurbakterien, Jena, 1907, 17.) From Greek rhabdos, a rod, and monas, a unit (cell)

Purple sulfur bacteria, as a rule occurring singly, in the form of rather irregular, long rods to filaments, exhibiting more or less pronounced swellings, or club and spindle shapes. Filamentous structures sometimes with constrictions giving the filament the appearance of a string of beads. These may be surrounded by a relatively inconspicuous slime capsule which can be rendered visible by India ink. The less distorted cell types are frequently mottle, flagella polar. Produce bacterio-chlorophyll and carotenoid pigments, coloring the cells pinkish to purplish red.

larity of its members to species of Chromatium and the occurrence of many inter-

Impér. Bot. St. Pétersb., 3, 1903, 116), van Niel (3-ak / 31 b-alic) e 1901 é Ellis (Sulphur Bacteris, London and New ?

 damm (Die farblosen und roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 129) favor generie rank.

The type species is Rhabdomonas roscus Cohn.

### Key to the species of genus Rhabdomonas.

- Cells not containing calcium carbonate inclusions in addition to sulfur globules a. Cells more than 3 microns in width.
  - 1. Rhabdomonas rosca.
  - aa. Cells less than 3 microns in width.
- 2. Rhabdomonas gracilis.
- II. Cells containing calcium carbonate inclusions in addition to sulfur globules.
  3. Rhabdomonas linsbaueri.

1. Rhabdomonas rosea Cohn. (Cohn, Beitr. Biol. Pfl., 1, Heft 3, 1875, 167; Beggiatea roseo-persteina Zopf, Z. Morphol. d. Spaltpflanzen, Leipzig, 1882, 39; Rhabdochromatium roseum Winogradsky, Schwefelbacterien, Leipzig, 18SS, 100; Rhabdochromatium fusiforme Winogradsky, biod., 102; Pseudomonas rosea Migula, in Engler and Prantl, Die naturlichen Pflanzenfam, 1, 1a, 1895, 30.) From Latin roseux, rose-colored.

Cells: Uneven in width and length, often swollen to spindle-shaped, sometimes tending towards filamentous The greatest width of a growth. spindle-shaped or fusiform cell may be close to 10 microns, in the more filamentous structures it is usually around 5 microns The length varies between 10 and 30 microns for single cells, filamentous forms, frequently showing bulges and constrictions suggestive of compound structures in which cell division has been incomplete, may attain considerably greater lengths, up to 100 microns. The ends of spindle-shaped cells often taper to very fine points or attenuated fibers; also filaments are generally tlunner toward the extremities. Single individuals and short filaments are motile by means of polar flagella, long filaments rarely motile. The ends of a filament may become purched off and swim away.

Color rose-red, cells are usually filled with sulfur globules

There is no good reason for maintain-

ing Rhabdomonas fusiformis (Rhabdochromatium fusiforme Winogradsky) as a separate species; the variations in size and shape bring this form well nithin the range of Rhabdomonas rosea. Present indications strongly suggest that the latter species should be regarded as a peculiar developmental form of Chromatium obenii.

Habitat: Mud and stagnant water containing hydrogen sulfide and exposed to light; sulfur springs.

Hinstrations: Cohn, loc. cit., Pl.YI, fig. 14; Warming, Vidensk Meddel naturhistor. Foren, Kjöbenhavn, 1876, Pl. VII, fig. 1e-e; Zopf, loc cit., Pl. VI, fig. 2b; Winogradsky, loc. cit., Pl. IV, fig. 9-11, 13-14.

2. Rhabdomonas gracilis (Warming)
Migula. (Monas gracilis Warming,
Vidensk, Meddel, naturhist, Foren,
Kjöbenhavn, 1876, 331; Rhabdochromatum minus Winogradsky, Schwefelbacterien, Leipzig, 1888, 102, Rhabdokromatium gracile Migula, Syst. d.
Bakt., 2, 1900, 1949, Rhaddocapa suspensa Mosto, Die Purpurbskterien,
Jena, 1907, 17; Rhabdomonas minor
Bergey et al., Manual, 3rd ed , 1330,
532) From Latin gracilis, slender.
Cells. Much smaller than those of

Cetts. Atten shared with less tendency to form fusiorm cells. Usually filamentous, more or less cylindrical, often with constrictions, but found up to 60 microns in length. Shorter filaments motile. Polar flagellate. Slime formation may occur under special conditions. Rose red. Sulfur globules. Probably an abnormal growth form of Chromatium turosum.

Habitat Mud and stagnant water containing hydrogen sulfide and exposed to light, sulfur springs

Illustrations: Warming, loc cit, Pl. VII, fig 5; Winogradsky, loc cit., Pl IV, fig 12, Molisch, loc cit, Pl II, fig. 11-12

3 Rhabdomonas linsbaueri (Gicklhorn) comb nov. (Rhabdochromatum linsbaueri Girklhorn, Ber d deut bot Ges, 39, 1921, 312.) Named for the botanist, K Linsbauer.

Cells Resemble Rhabdomonas rosea,

irregular, rod-shaped, 3 to 5 microns wide, up to 30 microns in length.

The characteristic feature of the species, and the chief means of differentiation, is the occurrence of calcum carbonate inclusions in addition to the sullur globules in the cells. Whether this is strictly an environmentally conditioned characteristic, due to the photosynthetic development of the bacteris in a medium rich in calcium ions, so that calcium carbonate is precipitated as the alkalinity increases, has not yet been established, but seems possible. In that case the identity of this species with Rhabdomonas rosea would become evident

Source From a pond near Graz, Austria.

Habitat: Fresh water.

### Genus XII. Rhodothece Molisch.

(Die Purpurbakterien, Jens, 1907, 19) From Greek rhodon, rose and theke, container, capsule

Purple sulfur bacteria, occurring singly, not aggregated in families. Cells aphetical, each surrounded by a rather wide capsule which is, however, rarely visible without special staining. Motity not observed Contain bacteriochlorophyll and carotenord pigments, coloring the cells reddish. Capable of photosynthesis in the presence of hydrogen sulfide; the cells then store sulfur globules, arising as an intermediate ordation product of the sulfide

In view of the experiences of Bavendamm and others that a number of representatives of the purple sulfur bacteria, characterized by typical colonial aggregates when found in nature, may develop as single cells in pure culture, it is quite conceivable that the genus Rhodothece is synonymous with some other genus, e.g., Lamprocystis, and that the two genera represent different growth forms induced by environmental conditions.

The type species is Rhodothece pendens Molisch

 Rhodothece pendens Molisch (Die Purpurbakterien, Jena, 1907, 19) From Latin penden, to be suspended

Cells Spherical, frequently occurring as diphosoric, occasionally as very short chains or clumps of 3 to 5 individuals 18 to 25 microns in diameter. Produce rather abundant slime Cells embedded in individual capsules which are rarely visible without staining [India ink). Characteristic is the regular occurrence of pseudos acustos. (accomes) which

are supposed to keep the cells suspended in hquid media. Refractive phenomens due to the pseudovacuoles and to the sulfur globules distort the cell shape under ordinary illumination so that bacteria appear as polygons rather than round cells. Usually 2 acrossomes and 2 sulfur globules per cell. Color not observable in individual bacteria Cell groups are row-red. Motility not observed.

Habitat Mud and stagnant water con-

taining hydrogen sulfide and exposed to light. Not reported from sulfur springs.

Illustrations: Molisch, Die Purpurbakterien, Jena, 1907, Pl. II, fig. 13-14

# Genus XIII. Chromatium Perty.

(Perty, Zur Konntnier Heinster)
Jensen, Cent. [ ]
Cells occur a

last-mentioned are often thick-cylindrical with rounded ends. Motile by means of polar flagella. Contain bacteriochlorophyll and carotenoid pigments, coloring the cells various shades of red. Capable of photosynthesis in the presence of hydrogen sulfide and storing elementary sulfur as an incomplete oxidation product in the form of globules inside the cells.

At present, the genus contains 11 described species and one variety. In addition, to o more purple sulfur bacteria, Pseudomonas molischii Bersa (Planta, §, 1926, 373) and Thiospirillum cocineum Hams (Jour. Sci. Hiroshima Univ., Ser. B, Div. 2, Bot., 1, 1933, 153), have been incorporated here as species of Chromatium because the descriptions and illustrations furnished by the original authors leave no doubt as to their taxonomic alfiliations.

Differentiation of species has, in the past, been based almost entirely upon size and shape of individual cells, often with complete disregard for the variability of these criteria. The unsatisfactory and arbitrary nature of such a classification has occasionally been pointed out, and with much justification. Winogradsky (Schwelelbacterien, Leipzig, 1888, 99) mentions the many transitional stages that can be observed between Chromatium okensi and Chromatium weissei: Strzeszewski (Bullet. Acad. Sci., Cracovie, Ser. B, 1913, 321) holds that it is impossible to distinguish, on the basis of sizes or otherwise, between Chromatium weisser and Chromatium minus. Such contentions, derived from observations on material from natural collections of crude cultures, have been greatly strengthened by studies with pure cultures of species of Chromatium. Thus van Niel (Arch. f. Mikrobiol., 3, 1931, 59) reported variations in width from 1 to 4 microns, and in length from 2 to 10 microps or even up to 50 microns: Manten (Antonio van Leeuwenhoek, 8, 1942, 164 ff.) found size differences of 1 to 14 microns with a pure culture of an organism that he identified as Chromatium okensi. Often the differences in size of a pure culture can be related to special environmental conditions. On account of such results a des gnation of species on the basis of size relations alone is manifestly unsatisfactor. Moreover, the available data do not suggest that differences in shape, color or arm igement of sulfur globules can be used more effectively. Lack of adequate experim atal results with a sufficiently large number and variety of pure cultures prevents a more rational classification at present.

The previously proposed species have been listed below with their respective characteristics and arranged as far as possible in the order of decreasing width.

Two Chromatium species have been described as containing inclusions of calcium carbonate in addition to sulfur globules. As in the case of Rhabdomo as lineburri, it is not known whether this feature may be a direct consequence of the calcium content and pli of the environment, and thus fail to have taxonomic significance.

The type species is Chromatium okenii Perty.

 Chromatium gobil Issatchenko. (Recherches sur les microbes de l'océan Named for Prof. X. Gobi. Cells: 10 microns by 20 to 25 microns. Source: From sea water of Arctic

Habitat: Presumably ubiquitous in the colder portions of the Ocean at least. Illustration: Issatchenko, loc cit., Pl. II. fig. 12.

2 Chromatium warmingil (Cohn) Migula (Monas warmingil Cohn, Beitr. Biol Pfl, 1, Heft 3, 1875, 167; Migula, Syst d Bakt, 2, 1900, 1048.) Named for the Danish botanist, Eugene Warm-

Cells 8 by 15 to 20 microns, also smaller (Cohn).

Illustration: Cohn, loc. cit., Pl VI, fig. 11

2b. Chromatiumwarmingii forma minus Bavendamm. (Die farblosen und roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 127) Named for the Danish botanist. Eugene Warming.

Cells. 4 by 6 to 10 microns.

Illustrations: Bavendamm, loc cit., 91, fig 7, and Pl II, fig 12, a-b.

3 Chromatium linsbaueri Gickihorn. (Ber d deut botan Ges., 59, 1921, 312) Named for the Austrian botanist, K Linsbauer

Cells. 6 by up to 15 merons (Grcklhorn), 6 to 8 merons in width (Ellis, Sulphur Dacterns, London and New York, 1932, 147) Special characteristic is the occurrence of calcium carbonate inclusions Otherwise resembles Chromatium obenii

Source From a pool in the Stiftingtal, pear Graz, Austria.

Habitat: Fresh water.

Illustrations: Gicklhorn, loc ett., 314, fig 1, Ellis, loc ett., 148, fig. 31.

i Chromatium okenii (Ehrenberg) Perty (Monas okenii Ehrenberg, Infusionsthierchen, Leipzig, 1838; Perty, Zur Kenntniss kleinster Lebensformen, Bern, 1852, 174; Bacillus okenii Trevisan, I generi e le specie delle Batteriacce, 1859, 18; Bacterum okenii DcToni and Trevisan, in Saccardo, Sylloge Fungorum, 6, 1889, 1027; Pseudomonas okenii Migula, in Engler and Prantl, Die natürlichen Pflanzenfamilien, 1, 1a, 1895, 30) Named for the German naturalist, L. Oken This is the type species of genus Chromofilum.

Cells: 56 to 63 by 7.5 to 15 microns (Cohn); minumum width 4.5 microns (Issatchecko, Borodin Jubilee Vol., 1929); 8); with many transitions to Chromatum verissei (Winogradsky, Schwefelbacterien, Leipzig, 1838, 92). Also, 35 by 8 to 12 microns and varying in size from 1 to 15 microns (Manten, Antonie van Leeuwenhock, 8, 1942, 163).

Illustrations: Cohn, Beitr Biol. Pf., I, Helt 3, 1875, Pl VI, fig. 12, Winogradsky, loc cit, Pl. IV, fig 3-4, Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig 9.

5 Chromatium weissel Perty. (Perty, Zur Kenntness kleenster Lebensformen, Bern, 1832, 174, Bacillus uesssii Trevisan, I genern ele speceo delle Batteriaceo, 1889, 18, Bacteruim uressi: DeTom and Trevisan, in Saccardo, Sylloge Fungorum, 3, 1889, 1027.) Named for the zoologist, J F Weisse, consequently the more common spellings, Chromatium weissis of C. utestis are in error.

Cells. 4.2 by 5.7 to 11.5 microns (Ferty); also 3 to 4 by 7 to 9 microns (Issatchenko, Borodin Jubilee Volume, 1929?, 8); transitions to Chromatium okenti (Winogradsky, Schwefelbacteren, Leipzig, 1888, 92); transitions to Chromatium minus (Streszenski, Bull. Acad Sci., Cracovic, 85r. B. 1913, 321).

Hustrations Winogradsky, loc. cit, Pl IV, fig. 1-2; Miyoshi, Jour. Coll. Sci., Imp. Univ. Tokyo, Japan, 10, 1897, Pl. XIV, fig. 15.  Chromatium cuculliferum Gickihorn. (Cent. f. Bakt., II Abt., 50, 1920, 419.) From Latin eucullus, cap or hood and fero, to bear.

Cells: 4 by 6 to 8 microns (Gicklhorn); according to Bavendamm (Schwefelbakterien, Jena, 1921, 127) dentical with Chromatium warmingis forma minus. Gicklhora claims this organism to be colorless, which appears very doubtful.

Source: From the pond in the Annen Castle Park, Graz, Austria.

Habitat: Fresh water ponds.

Illustration: Gicklhorn, loc. cit., fig. 2.

 Chromattum minus Winogradsky. (Winogradsky, Schwefelbacterien, Leipzig, 1888, 93; Bacillus minor Trevisan, I generi e le specie delle Batteriacee, 1889, 18; Bacterium munus DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 1027 ) From Latin minus, small.

Cells. 3 by 3 5 to 7 microns (Winogradky); also 1.7 to 3 microns in width and up to 8 5 microns in length (Issatchenko, Borodin Jubilee Volume, 1929, 3); all transitions to Chromatium weekset from which it cannot be distinguished (Strzeszewski, Bull Acad Sci, Cracovic, Sér B, 1913, 321).

Illustrations. Winogradsky, loc. ett., Pl. IV, fig 5; Miyoshi, Jour Coll Sci, Imp. Univ, Tokyo, Japan, 10, 1837, Pl XIV, fig. 16, Issatchenko, Recherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, Pl. II, fig. 10-11.

8. Chromatium vinosum (Ehrenberg) Winogradsky (Monas vinosa Ehrenberg, Die Infusionstierehen, Leipzig, 1838, 11; Winogradsky, Schwefelbacterien, Leipzig, 1888, 99; Bacillus

vinoardo,

Sylloge Fungorum, 8, 1889, 1021.) From Latin vinosus, pertaining to wine, winecolored Cells: 2 by 2 5 to 5 microns; also 1.4 to 3 by 1.5 to 5 microns (Jimbo, Botan Magaz, Tobyo, 5.1, 1937, 872); 1.7 to 2 by 2 to 9 microns (Issatchenko, Bordan Juhite Volume, 1929, 9); or 1 to 13 microns by 2 5 to 3 microns (Schramacck, Beitr. Biol. d. Pfanzen, 22, 1935, 317). Jimbo considers Thoderma roseum Micyoshi to be identical with Chromatum vinosum.

Hlustrations: Winogradsky, lec. cit, Pl. IV, 6-7; Miyoshi, Jour. Coll. Sci, Imp. Univ. Tokyo, Japan, 16, 1837, Pl XIV, fig. 17; Nadson, Bull. Jard Imp. Botan., St. Pétersbourg, 12, 1912, Pl. III. fig. 1-2.

 Chromatium violaceum Perty.
 (Zur Kenntniss kleinster Lebensformen, Bern, 1852, 174) From Latin tiolaceus, violet-colored.

Cells: About 2 by 2 to 3 microns. According to Cohn (Beitr. Biol. Pfl., 1, Heft 3, 1875, 166) probably identical with Chromatium vinosum. Apparently includes various sites.

10. Chromatium molischii (Berss) comb nov. (Pseudomonas molischii Berss, Plania, 2, 1926, 375) Named for the Austrian botanist, H. Molisch.

Cells. About 2 by 2.5 to 8 microns-Supposedly contains calcium carbonate as inclusions

Illustration: Bersa, loc. cit., 376, fig 3

11 Chromatium gracile Strzeszenski. (Bull Acad Sci., Cracovie, Sér. B, 1913, 321.) From Latin gracilis, slender

Cells 1 to 13 by 2 to 6 microns; also to 15 micron in width (Issatchenlo, Etudes microbiologiques des Lacs de Boue, Leningrad, 1927, 114).

Hiustration: Strzeszewski, loc. ct., Pl. XXXIX, fig. 1-2; Tokuda, Botan. Magaz , Tokyo, 50, 1936, 339, fig. 1-23.

 Chromatium minutissimum Winogradsky (Winogradsky, Schwefelbac-

terien Leinzig 1888 100 Racillus minulissimus Trevisan. I generi e le specie delle Batteriacee, 1889, 18. Bacterrum minutissimum DeToni and Trevisan in Saccardo, Sylloge Fungarum, 8. 1889 1028) From Latin minutes and diminutive, very minute

Cells: About 1 to 12 micron by 2 mierons. Also from 0.5 to 0.7 micron by 0.6 to 1 migron (Issatchen) a Racherches sur les microbes de l'océan glacial arctique, Petrograd, 1914, 253); and 1 to 3 migrous by 2 to 5 microns (Issatchenko. Borodin Jubilee Volume 19992 (1)

Illustrations, Winogradsky, Inc. est.

Pl IV, fig 8: Miyoshi, Jour, Coll Sci .

#### APPENDIX TO FAMILY THIORHODACAE

Three genera of sulfur purple bacteria have been proposed whose place and nature are at present very doubtful. They follow here-

n Thiosphaerion Mivoshi, with the single species Thiosphaerion violaceum Miyoshi (Jour. Coll. Sci., Imp. Univ., Tokyo, Japan. 10, 1879, 170) Occurs in round colonies in which numerous bactoria are held together by mucus, though not in a clearly discernible common cap-Individual cells ovoid, about 15 to 2 by 2.5 microns, motile Resembles Lamprocustis roscopersicing in many respects Reported once from Yumata Hot Springs, near Nikko, Japan,

Illustrations: Mivoshi, loc cit. Pl XIV. fig. 24 a-b

b Petochromatium Lauterborn, with the single species Pelochromatium roseum Lauterborn (Verhand) naturbust medizin Vereins, Heidelberg, N.F. 13, 1915, 421) Forms small colonies in which the bacteria are regularly arranged in about 5 rows, from 2 to 4 cells high, around a colorless central body. The entire colony actively motile and bebases like a single unit. Individual cells bean- or vibrio-shaped, about 1 miceon or less by 2 microns, the barrelshaped colony measures 25 to 4 by 4 to 8 Imp. Univ., Tokyo, Japan, 10, 1897, Pl. VIV 60 18

Anneadly: The measurements for Thiospirillum coccaneum Hama (Jour Sci. Huroshima Univ. Ser. B. Div. 2. Bot. 1 1933, 158) which, according to description and figures (shid., Pl 18, fig. 2: Pl. 10 fig 2), is an unquestionable species of Chromatium, are given as 2 by 4 to 15 microns It thus closely recombles the bacteria of the Chromatium minus C vinosum, C. violaceum, and C. moleschut group. Chromatium sphaeroides Hama, loc. cit.

Thiospirillum violaccum (Warming) Winneradsky is probably also a member of this assemblage.

microns. The structure may represent a complex of a colorless central bacterium surrounded by purple bacteria. analogous to Chlorochromatium agaregatum Lauterborn. Whether such structures have generic or even specific taxonomic significance romains determined. The lack of information concerning the occurrence of sulfur globules in the cells makes it doubtful whether the organisms are sulfur purple bacteria at all Found twice by Lauterborn in mud samples.

Illustrations Lauterborn, loc. cit , Pl. III. fig 28, a-c.

Utermohl suggested the name Lauterbornsola minima Utermöhl (Biol Zentralbl . 45, 1921, 605) for the small brownish bacteria which form the covering of the central body of Pelochromatium roseum, according to this author the central body is a larger bacterium, 1.5 by 7 microns which he named Endosoma palleum.

c. Thioporphira Ellis, with the single species Thioporphyra volutans Ellis (Jour. Roy. Technic, Coll Glasrow. 1926, 165). The account of this pleomorphic organism, which is claimed to multiply by fission, budding, and probably spore formation, is wholly unconvincing. The shape and size of some of the cells make it appear likely that Ellis observed maxtures of various kinds of purple sulfur bacteria.

Hustrations: Ellis, loc. cit., 166, fig. 1-14; 171, Micro. 1; 172, Micro. II; Sulphur Bacteria, London and New York, 1932; 153, fig. 33; 154, fig. 34; 156, fig. 35; 158, fig. 36.

Finally, there exist some, as yet unnamed, red to purple bacteria which contain bacteriochlorophyll and carotenoid pigments, are capable of photosynthesis

in the presence of hydrogen sulfide, but excrete elementary sulfur as an intermediate oxidation product instead of storing sulfur globules inside their cells (van Niel, Arch. f. Mikrobiol , 3, 1931, 63). They are small motile rods, vibries or spirilla, about 0 5 by 1 to 2 microns They may also occur as spherical cells of about 1 micron in diameter. They can readily be grown in organic media, under anaerobic conditions, in illuminated cultures and may be included either with the sulfur purple bacteria or with the non-sulfur purple bacteria, among which Rhodopseudomonas palustris is equally capable of photosynthesis in the presence of reduced inorganic sul fur compounds

#### FAMILY II. ATHIORHODACEAE MOLISCH.\*

(Molisch, Die Purpurbakterien, Jena, 1907, 28; Rhodobacterioideae Buchanan, Jour. Bact., 5, 1918, 471; Athiorhodobacteria Bavendamm, Ergeb. Biol., 15, 1936, 49.)

Unicellular bacteria, of relatively small size, occurring as spheres, short roda, vibrios, long rods and spirals Motility is due to the presence of polar flagella Gram-negative. They produce a pigment system composed of bacteriochlorophyll and one or more carotenoids, coloring the cells yellowish-brown, olive brown, dark brown or various shades of red Color usually not observable with single cells but only with cell masses. Generally microaerophilic, although many representatives may grow at full atmospheric oxygen tension. Capable of development under strictly namerobic conditions, but only in illuminated cultures by virtue of a photosynthetic metabolism. The latter is dependent upon the presence of extraneous hydrogen donors, such as alcohols, fatty acids, hydroxy- and keto-acids, and does not proceed with the evolution of molecular oxygen. Those members which can grow in the presence of air can also be cultivated in darkness, but only under aerobic conditions.

Key to the genera of family Athlorhodaceae.

I Cells red-shaped or spherical, not spiral-shaped
Genus I. Rhodovseudomonas, n 861.

II. Cells spiral-shaped

Genus II Rhodospirillum, p. 866.

Genus I Rhodopseudomonas Kluyver and van Niel emend. van Niel.

(Includes Rhodobacillus Molisch, Die Purpurbakterien, Jena, 1907, 14; Rhodobacterium Molisch, ibid., 16; Rhodococcus Molisch, ibid., 20; Rhodovitro Molisch, ibid., 21; Rhodocystis Molisch, ibid., 22; Rhodornetoc Molisch, ibid., 23; Rhodophacra Buchanan, Jour Bact, 3, 1918, 472; Rhodornhagus Bergey et al., Manual, 3rd ed., 1930, 535; Rhodomonas Kluyver and van Niel, Cent. f. Bakt., 11 Abt., 94, 1938, 337; not Rhodomonas Orla-Jensen, Cent. f. Bakt., 11 Abt., 24, 28, 1900, 331; Kluyver and van Niel, in Czurda and Maresch, Arch f. Mikrobiol, 8, 1937, 119, van Niel, Bact. Rev., 8, 1944, 85). From Greek rhodon, red and pseudomonas, false unit.

Spherical and rod-shaped bacteria, motile by means of polar flagella. Gramnegative. Contain bacteriochlorophyll which enables them to carry out a photosynthetic metabolism. The latter is dependent upon the presence of extraneous oxidirable substances and proceeds without the evolution of molecular oxygen. Though some members can voidire inorganic substrates, none appears to be strictly autotrophic, due to the need for special organic growth factors. Produce accessory pigments causing the cultures, especially when kept in light, to appear in various shades of brownish-yellow to deep red.

The genus includes the members of Molisch's genera Rhodobacterium, Rhodobacillus, Rhodosibrio, Rhodocystis, Rhodonostoc and Rhodococcus, as well as the genera Rhodosphacra Buchanan, Rhodorrhagus Bergey et al. and Rhodomonas Kluyver and van Niel.

The type species is Rhodopseudomonas palustris (Molisch) van Niel.

Completely revised by Prof. C B. van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

# Keys to the species of genus Rhodopseudomonas.

- I. Based upon morphological characters.
  - 1. Cells clearly rod-shaped in all media.
    - a. Cells short, somewhat curved, to long branched rods, size of young and short cells 0.6 to 0.8 by 1 2 to 2 microns; in older cultures up to 10 microns long; do not form slime; liquid cultures, when young, or after shaking, evenly turbid. Color red to dark brown-red.
      - 1. Rhodopseudomonas palustris.
    - aa. Cells siender rods, 0.5 by 1.2 microns usually clumped together in extensive slime masses. Cultures pale brown to peach-colored.
      - Rhodopseudomonas gelatinosa.
  - 2. Cells more or less spherical in media at pH below 7.
    - a. In media at pH about 7 clearly rod-shaped, 1 by 1 to 2.5 microns. Chains of cells frequent, and in characteristic zigzag arrangement. 3. Rhodopseudomonas capsulatus.
    - aa. In media at pH above 7 cells still predominantly spherical, 0.7 to 4 mierons in diameter. Mostly single, little tendency to chain formation. 4. Rhodopseudomonas spheroides
- II. Based chiefly on physiological properties.
  - 1. Gelatin liquefied
  - Rhodopseudomonas gelatinosa. 2. Gelatin not liquefied.
  - - a Does not produce mucus in media at pH above 8. Color the same under serobic and anserobic conditions of growth. 1 Rhodopseudomonas palustris.
    - aa. Produce mucus in media at pH above 8. Color brown in anaerobic, red in aerobic culture.
      - b. Develops readily in media with 0 2 per cent propionate as the chief oxidation substrate. Mucus production marked at pH above 8, but very limited between 7 and 8.
        - 3. Rhodopseudomonas capsulatus.
      - bb. Does not develop in media with 0 2 per cent promonate as the main oxidation substrate Slime formation extensive at pH above 7.
        - 4. Rhodopscudomonas spheroides.
- III. Based principally upon biochemical characters.
  - 1. Thiosulfate used as main oxidation substrate.
    - 1. Rhodopseudomonas palustris.
  - Thiosulfate not used.
    - a. Propionate (0 2 per cent) used.
      - 3. Rhodopseudomonas capsulatus.
    - aa. Propionate not used.
      - b Mannitol and sorbitol (0.2 per cent) used.
        - 4. Rhodopseudomonas spheroides.
      - bb Mannitol and sorbitol not used. 2 Rhodopseudomonas gelatinosa.

1 Rhodopseudomonas palustris (Molisch) van Niel. (Rhodobacillus palustris Molisch, Rhodobacilerium capsulatum Molisch and Rhodoribrio parvus Molisch, Die Purpurbakterien, Jenn, 1907, 14, 18 and 21, Rhodomonas palustris Kluyver and van Niel, Cent. f Bakt, JI Abt, 94, 1936, 397; Rhodopseudomonas No 9 and No 16, Czurda and Maresch, Arch f Mikrobiol, 8, 1937, 129; van Niel, Bact Rev, 8, 1944, 89) From Latin paluster, hoery, marshy

Cells: Usually distinctly rod shaped. though in young cultures very short. hightly curved rods may often predominate. Size variable, even for the same strain, and strongly influenced by age of culture and composition of medium Rather consistently short cells in young cultures in yeast extract, esnecially when incubated anaerobically in the light, or in angerobic cultures with substrates which permit only a slow and scanty development, such as malonate Dimensions in such cultures 0.6 to 0.8 by 1 2 to 2 microns More often, especially in older cultures, cells are much longer. up to 10 microns Highly characteristic is the propounced tendency to the formation of irregularly shaped, bent and crooked long rods, occasionally swollen at one or both extremities, and frequently suggesting branching, Such cells usually form clusters reminiscent of Corunebacterium and Mucobacterium cultures.

Cells in young cultures actively motile by means of polar flagella, irregular and long cells as a rule non-motile Gramnegative.

Growth in liquid media never mucoid, sediment in older cultures homogeneous and smooth, readily redispersible

Color Varies considerably, depending upon the medium, and especially in anacrobic illuminated cultures. Where development is slight (as in malonate, thosulfate, and, usurily, effector incide), the color is a light pink; in fatty acid-containing media more nearly dark reddsh-brown. Color due to bacterio

chlorophyll and a number of different carotenoid pigments, most strains produce in addition a water-soluble, noncarotenoid, bluish-red pigment which diffuses into the culture medium.

In yeast extract cultures growth is possible over the range pH 6 to 8.5. With certain substrates, especially fatty acids, the combined effect of low pH and a substrate concentration of 0 1 to 0.2 per cent may prevent growth No characteristic odors save that old cultures may develop a distinct ionone-like fragrance Gelatin is not inquefied; leucine is generally utilized as a substrate

Most strains are able to grow on the surface of agar plates or slants; a few, especially when first isolated, appear more sensitive to ovygen and developonly in stabs in which the upper region may remain free of growth. Generally such strains can be adapted to grow at full atmosoberic oxygen tension.

Most fatty acids and hydrory acids are adequate oridation substrates. All cultures can grow at the expense of thiosulfate and produce rapid and profuse growth in glutarate and ethanol media. No development in media containing as the chief ovidation substrate 0.2 per cent sorbitol, glucose or mannose, even though these substances are not inhibitory. Molecular hydrogen can be oudgred.

All cultures can develop anaerobically in illuminated cultures by photosynthesis

Temperature optimum generally rather high, good development being possible up to 37°C However, certain strains exhibit a lower temperature entimum

Distinguishing characteristics: Morphological resemblance to species of Mycobacterium in old cultures, ability to grow with thousulfate as the chief ordinable substrate, and failure to develop in media which contain carbohydrates or sugar alcohols in a concentration of 0.2 per cent as the mun oudizable compounds

Habitat: Regularly found in mud and stagnant bodies of water.

Hustrations: Molisch, loc. cit., Plate I, fig. 1, 2; Plate II, fig. 10; van Niel, loc. cit., fig. 1-3, p. 18, and fig. 18-20, p. 90.

Rhodopseudomonas gelatinosa (Molisch) van Niel. (Rhodocystis gelatinosa Molisch, Die Purpurbakterien, Jena, 1907, 22; van Niel, Baet. Rev., 8, 1944, 98.) From Latin gelatio, freezing, indicating solidification, or in this case, elumping.

Cells: In young cultures, short and small rods, approximately 0.5 by 1 to 2 microns. In old cultures much longer, up to 15 microns, and then irregularly curved rods, often swollen and gnarled in places up to 1 micron in width. In this stage the cells bear some resemblance to those found in old cultures of Rhodopscudomonas palustris, but the characteristic Mycobacterium-like clusters of the latter are absent. Single cells infrequent due to a copious mucus production in all media which causes the cells to clump together While young cells are actively motile by means of polar flagella, motility is often difficult to ascertain as a result of the pronounced tendency to conglomerate; the individuals in the clumps appear to be non-motile Gram-negative. Gelatin is liquefied, of the single amino acids alaniae, asparagine, aspartic and glutamic acids appear generally satisfactory substrates.

Color: Quite distinctive in most anaerobic cultures as a pale, delicate, pinksils shade, rather peach-colored Only in the presence of rather high concentrations of yeast extract when a much heavier growth is obtained than with low concentrations supplemented with 0.2 per cent of various single exidation substrates) do the slumy cell masses appear a dirty, faded brown Color is due to bactericallorophyll and carotenoid pigments Occasionally a water-soluble, non-carotenoid, bluish-red pigment is produced which diffuses into the culture medium.

In yeast extract, growth occurs over a pH range extending from at least 6.0 to 8.5.

Cultures produce a characteristic acrid odor.

More sensitive to fatty acids than other species of Rhodopseudomonas; with 0.2 per cent propionate no growth occurs. The best single oxidizable substrates appear to be ethanol, glucose, fructose and mannose, as well as a variety of amino acids. Citrate also permits good growth; not, on the other hand, glycerol, mannitol, sorbitol or tartrate in the usual concentration of 0.2 per cent

Thiosulfate is not oxidized; behavior

towards molecular hydrogen unknown More pronouncedly microaccophilic than the other Rhodopseudomonas species; most cultures cannot develop on aerobically incubated slants or agar plates.

Capable of strictly anaerobic development in illuminated cultures by virtue of a photosynthetic metabolism.

Temperature relations so far unknown. Distinguishing properties: The small size of the individual cells, and the pronounced elumping which causes the cultures to be exceptionally strings; the nunsual color of the cell masses; the ability to liquefy gelatin, to utilize distrate and a number of amino acids Correlated with these is the failure to grow in media with 0.2 per cent propionate, tartrate and giverol

Habitat: Regularly present in stagnant bodies of water and in mud.

Hustrations: Molisch, loc. cit., Plate I, fig. 8; van Niel, loc cit., fig. 55-60, \_ p 99; fig 61-66, p. 100

 Rhodopseudomonas capsulatus (Mohisch) van Niel. (Rhodonosioe coppulatum Molsch, Die Purpurbakterien, Jena, 1907, 23; van Niel, Bact. Rev., 8, 1944, 92.) From Latin capsula, container (sheath).

Cells: Depending upon the pH of the medium, cells nearly spherical, or as distinct rods often devoid of motility. Motility due to polar flagella spherical cells are found in media with a nH below 7: they are usually arranged in chains resembling streptococci channel calls are characteristic for modia with nH above 7: the higher the nH. the longer the rods. Individual cells slightly less than I micron wide although attenuated rods (about 0.5 micron in width) are frequent at pH above 8, and slightly swollen cells (to 1 2 microns) are found in media containing sugars Length varies from 1 to 6 microns, most common dimensions in approximately neutral media 2 to 25 micrors above 8 abnormal growth in the form of pregular filaments. Outstandingly characteristic is the zigzag arrangement of the cells in chains

Cultures in media of pH 8 or above are distinctly mucoid Gram-negative

Color Anneroluc cultures develop with a brown color, the shade ranging from a light yellowish-brown to a deep mabogany brown. When grown in the presence of oxygen, the cultures are dark red. Even the pigmentation of the brown-colored organisms from an anaeroluc culture can be changed into a distinct red by shaking a suspension with air for some hours, light enhances the rate of this color change. Golor due to bacteriochlorophyll and carotenoid pigments. No diffusible water-soluble pigment is produced.

Growth possible over a pH range from at least 6 to 8.5, morphology becoming abnormal in the alkaline media

abnormal in the alkaline media Most cultures are odorless, although occasionally a faint peach-like odor can

be detected
Growth is not inhibited by the presence of oxygen, although the pigmentation is thereby affected

Patty acids and most substituted acids are satisfactory substrates Rapid and abundant growth with propionate at a concentration of 0 2 per cent. At this same concentration glutaric acid leads, at best, to very meager cultures, while tartrate, citrate and gluconate fail to induce growth, as do also ethanol, glycerol, mannitol and sorbitol. In media with 02 per cent glucose or fructose good growth is obtained. No growth with mannose Thiosulfate is not, but molecular hydrogen can be, oxidated by this species.

Gelatin is not liquefied, of the amino acids alanine and glutamic acid are satisfactory substrates, while leucine is not utilized

Distinguishing properties: Cell shape and arrangement in chains; brown color of anaerobic, red pigmentation of aerobic cultures, ability to grow in media with 0.2 per cent propionate, glucose, fructose, alanine and glutamic acid; failure to develop with leucine, as well as with ethanol, glycerol, manntol and sorbitol in the above-mentioned concentration.

in the above-mentioned concentration.
All cultures can develop anaerobically in illuminated cultures by a photosynthetic metabolism

Temperature optimum distinctly lower than for Rhodopseudomonas palustris, and, as a rule, around 25°C

Habitat. Regularly found in stagnant bodies of water and in mud.

Illustrations Molisch, loc. cit., Plate II, fig. 9, van Niel, loc. cit., fig. 4-6, p 19, fig 27-32, p. 92, and fig. 33-33, p 93.

4 Rhodopseudomonas spheroides van Niel (Rhodesceur caprulatus Molisch), Die Purpurbakterien, Jena, 1907, 20; Rhedesceus minor Molisch, ibid., 21; Rhodosphaera caprulata Buchanan, Jour. Bact. 5, 1915, 472; Rhodosphaera minor Bergey et al., Manual, 1st ded., 1923, 495; Rhodorrhapus minor Bergey et al., Manual, 3rd ed., 1930, 535; Nahodorrhapus capsulatus Bergey et al., Manual, 3rd ed., 1930, 535; van Niel, Bact. Rev. 8, 1941, 95.) Trom Lattin sphaera, a round body and Greek cidas, form of.

Cells: Generally single, nearly spherital, diameter without slime capsule variable, depending upon malium, ranging from 0.7 to 4 microns. In young cultures actively motile by means of polar flagella; motility soon ceases in media which are or become alkaline. Copious slime production in media at pH above 7. In strongly alkaline cultures abnormal cell-shapes occur in the form of irregular, swollen and distorted rods, often having the appearance of soore-bearing cells, simulated by the production of fat bodies. In sugar-containing media egg-shaped cells, measuring as a rule 20 to 2.5 by 2.5 to 35 microns, are frequently found. Gramnegative.

Color: Anaerobic cultures develop with brown color, ranging in shade from a light, dirty greenish-brown to a dark brown. Cultures grown in the presence of oxygen are distinctly red. As in the case of Rhodopseudomonas capsulatus, the brown color of an anaerobic culture can be changed to red by shaking with air, light stimulating the color change. Color due to bacteriochlorophyll and carotenoid pigments. The large majority of cultures of this species produces in addition a water-soluble, non-carotenoid, bluish-red pigment which diffuses into the culture medium

Gelatin is not liquefied, and growth with single amino acids appears somewhat erratic. No definite correlations have been observed.

Development is possible over a wide pH range, extending from at least 60 to 8.5.

All cultures exhibit an unpleasant putrid odor.

Requires for optimal development higher concentrations of yeast extract as a supply of growth factors than either Rhodopseudomonas palustris or Rhodopseudomonas capsulatus and is more sensitive to low fatty said concentrations. With 0.2 per cent propionate in a neutral medium, no growth occurs, caproic and pelargonic acids are toxic in concentrations below 0.1 per cent. On the other hand, tartrate and gluconate can serve as oxidation substrates, as can also ethanol, glycerol, mannitol, sorbitol, glucose, fructose and mannose in 0.2 per cent concentrations.

In sugar-containing media, acid is produced; the pH may drop to below 40 before development ceases. Acid production from glucose occurs both in presence and absence of air, and in illuminated as well as in non-illuminated cultures In cultures exposed to light, the acid usually disappears later on.

Thiosulfate is not oxidized, hydrogen oxidation has not been observed.

Ovygen does not prevent growth, colonies develop on the surface of agar plates exposed to air, with a red pigmentation. Capable of strictly anaerobic development in illuminated cultures by photosynthesis.

Temperature optimum below 30°C. Distinguishing properties: Spherical cell-shape in most media; brown color of anaerobic and red pi-mentation of aerobic cultures; growth with 02 per cent tartrate, gluconate, ethanol, glycerol, mannitol, sorbitol, glucose, fructose and mannose; failure to grow with 0.2 per cent propronate.

Habitat: Regularly found in stagmint bodies of water and in mud.

Illustrations. Molisch, loc cit, Plate II, fig. 15; van Niel, loc. cit., fig. 7-8, p 19; fig. 39-45, p. 96, fig 40-54, p 97.

Genus II. Rhodospirillum Molisch emend. van Niel.

-halterien Jena, 1907, 24; van Niel, Bact. Rev., 8, 1944, 89; the ospirillum Kluyver and van Niel, Cent. f. Bakt., ck rhodon, red and M.L spirillum, spirillum.

Spiral-shaped bacteria, motile by means of polar flagella Gram-negative.

Contain bacteriochlorophyll and are potentially photosynthetic in the presence of extraneous oxidizable substances Molecular oxygen is not produced. Unable to grow in strictly mineral media, even when possessed of the ability to utilize hydrogen as oxidizable substrate, due to the need for organic nutrilites Produce accessory pigments causing the cultures, especially when grown in the light, to appear in various shades of red to brown

The type species is Rhodospirillum rubrum (Esmarch) Molisch

### Key to the species of genus Rhodospitillum.

- I Cultures red; cells well over 0.5 micron, usually about 1 to 1.2 microns in width
- II Cultures brown to orange: cells 0 5 meron or less in width.
  - 2. Rhodospirillum fulvum.

l Rhodospirillum rubrum (Lsmarch) Mohseh (Spirillum rubrum Esmarch, Cent f Bakt, 1, 1837, 225; Mohseh, Die Purputhakterien, Jean, 1907, 25; Rhodospirillum photometricum Mohseh, ibid, 21, Rhodospirillum giganteum Mohseh, ibid, 21; Rhodospirillum longum Hama, Jour Sei Hiroshima Univ, Ser B, Div 2, 1, 1933, 135; Rhodospirillum graele Hama, ibid, 150) From Latin ruber,

Cells Characteristically spiralshaped, but size of elements variable within wide limits, depending upon environmental conditions during growth Width of cells from 0.5 to 1.5 microns. length from 2 to 50 microns, and over, even in a simple culture such differences may be found. Also the shape and size of the spiral coil varies much at usually ranges between 1 to 4 microns in width. and from 1 5 to 7 microns in length alanine media the majority of the cells occurs in the form of half-circles to complate rings, malate media fend to produce much flattened spirals In old cultures involution forms ap-

per, straightened spirals and irregularly swollen cells, the latter common in media with higher fatty acids Such cells stain irregularly, contain fatty inclusions, and are occasionally branched

Mucus is not produced. In calciumdeficient media the growth is flocculent, as if agglutinated. With an adequate calcium supply the growth in liquid media is homogeneous, suspended, and consists of single cells

Young cultures show active motility, due to polar flagella Gram-negative

Gelatin is not liquefied; the amino acids alanine, asparagine, aspartic and glutamic acids are satisfactory oxidizable compounds

Color Ordinardy deep and dark red. without any brownish tinge. In othanol media lighter, and a characteristic pink Prement production markedly influenced by oxygen and light. Slants incubated in darkness present a pale gravish surface growth with a faint reddish hue. while often showing deep-red cell masses in the region between glass wall and agar surface where development proceeds at low ovegen tension The color is due to bacteriochlorophyll and carotenoid purments. Among the latter spirilloxan thin is quantitatively predominant Water-soluble, diffusible pigments are not produced.

Development possible over a pil range of at least 6 to 8.5, although, as in other cases, the combination of an acid reaction and the presence of fatty acids may prevent growth

Cultures produce a distinctive odor, reminiscent of slightly putrid yeast In general, grow well with fatty acids

as the chief oxidizable substrate; however, are prevented from growing by 0.2 per cent propionate in a neutral medium Most substituted acids are equally satisfactory, with the exception of tartrate, gluconate and citrate. In a concentration of 0.2 per cent, ethanol is a suitable substrate, whereas the carbohydrates and their corresponding polyaicohols are not utilized.

Thiosulfate is not oxidized; molecular hydrogen can be used by some strains.

Rather microaerophilic; many strains upon initial isolation incapable of growth at atmospheric oxygen tension. Subsequent adaptation can be induced. But even such adapted cultures exhibit negative chemotaxis to air.

Capable of strictly anaerobic development in illuminated cultures on the basis of a photosynthetic metabolism.

Temperature optimum generally between 30° and 37°C.

Distinguishing properties: The most important characteristics of the species are the spiral shape, combined with the ability to produce a red pigment with a definite absorption maximum at 550 millimicrons in the intact cells. Diagnostically useful are the good growth in media with 0.2 per cent ethanol, alanine, asparagine, aspartate or glutamate, and the inadequacy of similar concentrations of carbohydrates and thiosulfate as substrates.

Habitat: Regularly present in stagnant bodies of water and in mud.

Illustrations. Molisch, loc. cit., Plate I, fig. 5-7; van Niel, Baet Rev., 8, 1944, fig. 9-10, p 19; fig 11-16, p. 24; fig. 67-75, p. 103; fig. 76-84, p. 104; fig 85-90, p. 106; fig. 91-96, p. 107

 Rhodospirilium fulvum van Niel. (Bact. Rev., 8, 1944, 108.) From Latin fulvum, yellowish, tawny.

Characteristic for the species as the very small size of the individual cells. These are not over 0.5 micron wide, and generally not longer than 2.5 microns. The most common shape consists of a complete turn of about 1 by 1.5 microns. In media with fatty acids as a substrate the spirals appear somewhat steeper than in fumarate, succinate or malate cultures. Swellen individuals resembling

vibrios are encountered in cultures which do not appear quite healthy. Formation of mucus or elumping has not been observed.

Gelatin is not liquefied; aspartate has been the only amino acid capable of inducing growth Thiosulfate is not ovidized.

Color: Quite distinct from that of Mhodospirillum rubrum; colonies and stab cultures are a reddish-brown, while liquid cultures often appear brownish-orange. The color is due to bacterio-chlorophyll and carotenoid pigments; among the latter spirilloxanthin, as evidenced by the absence of an absorption maximum at 550 millimerons, is not represented as a major constituent. Does not produce water-soluble, diffusible pigments

Capable of strictly anserobic development in illuminated cultures, due to photosynthetic metabolism.

Fatty acids and the four-carbon disaboxylic acids are uniformly good substrates; glutarate is not used. Ethanol and glucose, in a concentration of 0.2 per cent, have yielded satisfactory cultures; other carbohydrates, as well as the corresponding polyalcohols, have given negative results.

Little information available concerning pH and temperature relations. Behaves generally as a strict anacrobe; adaptation to microacrophilic conditions has not been achieved. Negative acrotais very ronounced.

Distinguishing properties: The small size and the color of the cultures serve as adequate criteria for its differentiation from Rhodospirillum rubrum. The strictly anaecoloi nature and the failure to grow with gutarate and various amino acids evcept aspartate can probably be used as supplementary specific properties.

Habitat: Bodies of stagnant water and

Hustrations: Van Niel, loc cel , fig. 97-102, p. 109

#### FAMILY III. CHLOROBACTERIACEAE GEITLER AND PASCHER.\*

(Cyanochloridinas-Chlorobacteriaceae Geitler and Pascher, Die Süsswasserflora Deschlands, Österreichs und der Schweiz, Jena, 12, 1925, 451; Chlorothiobacteria Bavendamm, Ergeb. Biol., 13, 1935, 49)

Green bacteria, usually of small sire, occurring singly or in cell masses of various shapes and sires, developing in environments containing rather high concentrations of hydrogen sulfide and exposed to hight. As a rule not containing sulfur globules but frequently depositing elementary sulfur outside the cells. Contain green pigments of a chlorophyllus nature, though not identical with the common green plant chlorophylls nor with bacteriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfde; do not hiberate oxygen.

A number of genera have been proposed, characterized by special colonial growth forms, others on the basis of a supposed symbiotic habitus, where the green bacteria grow in more or less characteristic aggregates together with other micro-organisms. In view of the variations in size and shape exhibited by the only member of this group which has so far been obtained and studied in pure eulture (van Niel, Arch. f. Mikrobiol. 3, 1931, 63f) the validity of many of these genera is doubtful. The following keys and descriptions, therefore, bear a strictly provisional character. Here, as in the case of the sulfur purple bacteria, significant advances can only be expected from pure culture studies under controlled environmental conditions.

#### Key to the genera of family Chlorobacteriaceae.

- I Free-living bacteria not intimately associated with other microbes.
  - a. Bacteria not united into well defined colonies.
    - Genus I. Chlorobium, p. 869.
  - as Bacteria united into characteristic aggregates.
    - b. Bacteria without intracellular sulfur globules.
    - Genus II. Pelodictyon, p. 870
      bb. Bacteria with intracellular sulfur globules.
      - ular sulfur globules. Genus III. Clathrochloris, p. 872.
- II. Green bacteria found as symbiotic aggregates with other organisms.
  - a. Aggregates composed of green bacteria and protozoa.
    - Genus IV. Chlorobacterium, p. 872.
  - an. Aggregates composed of two different types of bacteria,
    - b. Aggregates small, barrel-shaped, actively motile, and consisting of a central, polarly flagellated, rod-shaped bacterium with a covering of green sulfur bacteria.
      - Genus V. Chlorochromatium, p. 873.
    - bb Aggregates large, cylindrical, non-motile, and composed of a central filamentous bacterium with a more or less extensive covering of green sulfur bacteria.

Genus VI. Cylindrogloea, p. 873

#### Genus I. Chlorobium Nadson.

(Nadson, Bull, Jard. Impfr. Botan., St. Pétersb., 12, 1912, 64 (Russian), 83 (German), Chloronosloc Pascher, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 455, Tetrachloris Pascher, sbird., 455; Sorochloris? Pascher,

<sup>\*</sup> Completely revised by Prof. C B van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

berg, N.F.

Vereins, Heidel-

Green sulfur bacteria, occurring singly or in chains, individual cells of various sizes and shapes, from spherical to relatively long rod-shaped, the latter sometimes coiled into timb smirely.

mon green; thesis in the presence of hydrogen sulfide, during which they produce elementary sulfur which is excreted outside the cells. Do not form spores

The type species is Chlorobium limicola Nadson,

1. Chloroblum limicola Nadson. (Nadson, Bull. Jard. Impér. Botan., St. Pétersb., 12, 1912, 64 (Russian), 83 (German); Chloronostoc abbreviatum Pascher. Süsswasserflora Deutschlands. Österreichs und der Schweiz, Jena, 12, 1925, 456; Tetrachloris inconstans Pascher, ibid., 456; Sorochloria aggregata? Pascher, ibid., 455; in part Peloglaca chlorina Lauterborn, Verhandl. naturhistor .- medizm. Vereins, Heidelberg, N.F. 18, 1915, 430.) From Latin. mud-dweller.

Cells: Various shapes and sizes, markedly dependent upon environmental conditions. In young and healthy state predominantly spherical to ovoid, about 0 5 to 1 micron in diameter, frequently united in chains resembling streptococci. Often cells become elongated and appear as rods, generally about 0.7 micron by 1 to 2.5 microns; also these may remain united in chains. Regularly produce mucus, causing the formation of cellconglomerates of different size and shape, but not, as a rule, of characteristic appearance.

Color yellowish-green. Non-motile Abnormal cell forms (involution forms) rather common. These may be larger spherical cells, up to 5 to 6 microns in diameter, the larger ones generally vacuolated, or long rods, occasionally club-shaped but more often coiled In rare cases the latter may be loosely wound. More frequently they are tightly-coiled screws, with cells of about 0 5 micron in diameter by as much as 15 nucrous in length. The spherical involution forms are normally encountered in acid, the coiled ones in alkaline en-

vironments.

Strictly anaerobic and apparently dependent upon hydrogen sulfide and leght. Development in organic media has not been obtained.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light, more rarely in sulfur springs

Hustrations: Nadson, loc. cit, Pl. III, fig. 3-12, van Niel, Arch. f. Mikrobiol., 5, 1931, 66, fig. 8.

## Genus II. Pelodictyon Laulerborn.

(Lauterborn, Allgem. botan. Ztschr., 19, 1913, 98; Verbandl. naturbistor. meditin. Vereins, Heidelberg, N.F. 18, 1915, 431; Schmidlea loc. ett., Lauterborn, Allgem botan. Zeitschr., 19, 1913, 97; in part, Pelogleac Lauterborn, Verhandl. naturbist-medizin Vereins, Heidelberg, N.F. 15, 1915, 430; Pedicokloris Geitler, Die Susswassreflora Deutschlands, Österreichs und der Schweiz, Jens, 12, 1925, 457.) From Greck pelos, mud and dietyon, net.

Green sulfur bacteria, individual cells avoid to distinctly rod-shaped, producing rather extensive mucoid capsules, and generally united into large colonies of characteristic shapes. Non-motile. Contain chlorophyllous pigments different from

the common green plant chlorophylis and from bacteriochlorophyli. Capable of photosynthesis in the presence of hydrogen sulfide, but do not store sulfur globules inside the cells.

The type species is Pelodictyon clathratiforms (Szafer) Lauterborn.

#### Ken to the species of genus Pelodiction.

- I Cells united in colonies in a net-like fashion.
  - 1. Pelodictyon clathratiforme.
- II. Cells arranged in tightly packed colonies without net-like structure.
  - a Colonies composed of irregularly arranged cell-masses, extending in three dimensions.
  - 2 Pelodictyon aggregatum aa Colonies consisting of parallel strands and extending in two dimensions. 3. Pelodiction necellatin
- 1 Pelodictyon clathratiforme (Szafer) Lauterborn (Aphanothece clathratiforme Szafer, Bull Acad Sci , Cracovie, Sér B, S, 1910, 162, Lauterborn, Allgem botan Zteschr, 19, 1913, 98, Lauterborn, Allgem botan Zteschr, 19, 1913, 98, Lauterborn, Verhandl naturhist-medizim Vereins, Heidelberg, NF. 15, 1915, 493, Pelodictyon clathratiforme Gettler, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 458; Pelodictyon lauterborni Gettler, ibrd. 458) From Greek clathros, trellis and formus share.

Cells Generally rod-shaped, ranging from slightly elongated ovoids to distinct rods, often vacuolated, about 0.5 to 1.5 micron by 2 to 4 microns, producing rather wide slime capsules, and characteristically united into three-dimensional colonies which present a not like appearance, with mazes of about 10 to 50 microns. Color vellowish-green. Non-motile

Abnormal cell forms (involution forms) not uncommon, consisting of clongated and curved, forked, or clubshaped and swollen rods, occasionally suggesting rudimentary branching at the extremities. Such cells may be found as elements in chains for the greater part composed of normal individuals.

Habitat. Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light; sulfur springs

Illustrations. Szafer, loc. cit, Pl. VI,

fig 5; Perfiliev, Jour. Microbiol., (Russian), 1, 1914, Pl. II, fig 1, 5-12; Lauterborn, leg cst., 1915, Pl. III, fig. 33

2 Pelodictyon aggregatum Perfilev. (Aphanothece luteda Schmidle, Beinefete Botan Cent , 10, 1901, 179; Schmidlez Luteola Lauterborn, Allgem. botan. Zischr. 19, 1913, 97; Lauterborn, Verhandl naturhistor-medium. Vereins, Heidelberg, Nr. 13, 1915, 429, Pelogloes bacillifera Lauterborn, ibid., 430; Perfilev. Jour. Microbiol (Russan), 1, 1914, 197) From Latin aggregatus, leading together, cropning.

Cells Usually rod-shaped, about 1 to 1 to 1 microns by 2 to 4 microns, often vscuolated, producing mucus capsules, and united into irregularly shaped, three-dimensional colonies in which the cells are more or less tightly packed, without orderly arrangement. Colonies may attain a size of up to 1 mm; frequently they are not fully compact, but contain less dense areas, or appear perforated, thus forming transition stages to Pelohetiyon elathratiforme. Colory velloush-green. Non-motile.

Abnormal cell forms (involution forms) usually in the shape of clongated and curved, forked or club-shaped and swollen rods, occasionally suggesting branching at extremities.

Habitat Mud and stagnant water, containing rather high concentrations of hydrogen sulfide, and exposed to light; sulfur springs.

Illustrations: Perfiliev, loc. cit . Pl. II. fig. 2: Lauterborn, loc, cit., Pl. III, fig.

3. Pelodictyon parallelum Perfiliev. (Aphanothece parallela Szafer, Bull. Acad. Sci., Cracovie, Sér. B, 3, 1910, 163; Perfiliev, Jour. Microbiol. (Russian), 1, 1914, 198; Pediochloris parallela Geitler, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 457.) From Latin parallelus, beside one another.

Cells: Rather small, spherical to ovoid, or even rad-shaped; about 0.5 to 1 micron by 1 to 3 microns, occurring in chains, and forming flat, plate-like, two-dimensional aggregates in which the chains are arranged as parallel strands.

Color yellowish-green. Non-motile.

Abnormal cell forms not specifically mentioned, but likely to occur, and to resemble those of other species.

This species may well be a special growth-form of Chlorobium limicola.

Habitat: Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light; sulfur springs.

Illustrations: Szafer, loc. cit., Pl. VI, fig. 7; Perfiliev, loc. cit., Pl. II, fig. 2

### Genus III. Clathrochloris Geitler.

(Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, Jens, 12, 1925, 457.) From Greek clathros, trellis and chloros, green.

Green sulfur bacteria of small size, generally spherical, and arranged in chains which are united into loose, trellis-shaped aggregates, somewhat similar to those of Pelodictyon clathratiforme and Pelodictyon aggregatum. Cells usually contain sulfur globules. Color yellowish-green. Non-motile.

The type species is Clathrochloris sulphurica (Szafer) Geitler.

 Ciathrochioris sulphurica (Szafer) Gentler. (Aphanothece sulphurica Szafer, Bull. Acad Sci , Cracovie, Sér. B, S, 1910, 162; Geitler, Die Süsswasserflora Deutschlands, Osterreichs und Schweiz, Jena, 12, 1925, 457) From Latin, containing sulfur.

Cells Spherical, about 0 5 to 0.7 micron in diameter, usually containing sulfur globules. Color yellowish-green. Non-motile.

The reported occurrence of sulfur globules in the cells of this very small species is surprising, it is the only one among the green sulfur bacteria in which these inclusions have been encountered The published descriptions are even more fragmentary than those of other members of the group

Source: Reported only from sulfur springs in Lubién Wielki, near Lnow,

Poland. Habitat: Mud and stagnant water containing rather high concentrations of

hydrogen sulfide and exposed to light; sulfur springs.

Illustration: Szafer, loe cit., Pl. VI, fig. G.

## Genus IV. Chlorobacterium Lauterborn. Verbandt naturhist medizin. Vereins, Heidelberg, N.F., 12, 1915,

- 3chneiz, Il rod. on cells curved.

of protozoa, such as amocha and nagenates. The type species is Chlorobacterium symbioticum Lauterborn. greenish. Non-motile.

1 Chlorobacterium symbloticum Lauterborn. (Lauterborn, Verhandl. naturhist.-medizin Vereins, Hendelberg, N F. 15, 1915, 429; Chroostipes linearis Pascher, Die Stisswasserfora Deutschlands, Österreichs und der Schweis, Jans, 12, 1925, 116.) From Greek, living symbiotically
Colls Rodeshared about 0.5 by 2 to 5.

Cells Rod-shaped, about 0 5 by 2 to 5 microns, often slightly curved Nonmotile

Occur as a peripheral covering of certain protozoa with which they may form a symbiotic unit. It is not certain that this is a green sulfur bacterium; the description of localities where it was found fail to mention the presence of hydrogen sulfide in the environment which should be a prerequisite for a member of this group

Source Reported from a number of

Habitat Stagnant water

Hilustrations: Lauterborn, loc cit., Pl III, fig 34-36; Pascher, loc. cit., fig 149

#### Genus V. Chlorochromatium Lauterborn

(Lauterborn, Allgem. botan Ztschr, 19, 1906, 196; Chloronium Buder, Ber. d. deut. bot Ges., 51, 1914, Generalversammlungsheft, 80) From Greek chloros, green and chroma, color.

Green sulfur bacteria, ovoid to rod-shaped with rounded ends, occurring as barrelshaped aggregates, consisting of a rather large colorless bacterium with a polar flagellum as the center, surrounded by the green bacteria, arranged in 4 to 6 rows, ordnarly from 2 to 4 cells high The entire conglomerate behaves like a unit, is motile, and multiplies by the more or less simultaneous fission of its components.

The green constituents contain a chlorophyllous pigment which is not identical with the common green plant chlorophylls or with bacteriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfide, but do not store sulfur globules in the cells.

The type species is Chlorochromatium aggregatum Lauterborn.

1 Chlorochromatium aggregatum Lauterborn (Lauterborn, Allgem botan Zischr, 19, 1905, 196, Chloronium mirabile Buder, Ber deut botan Ges, 51, 1914, Generalversammlungsheft, 80) From Latin aggregatus, grouped

Cells of the green component 0.5 to 10 by 10 to 2.5 microns, mostly from S to 16 individuals surrounding the central bacterium. Size of the total barrelsiaped unit variable, generally 2.5 to 5 by 7 to 12 microns. Occasionally a group of the complex colonies may remain at tached in a chain.

Anaerobic

Habitat Mud and stagnant water con

taining rather high concentrations of hydrogen sulfide and exposed to light.

There is at present no good reason for distinguishing 2 vancties (forma typica and forma minor) or even species, on the basis of size differences of the colony, as Gettler proposed (Die Süsansserflora Deutschlands, Österreichs und der Schweiz, Jena, 12, 1925, 400). The reported and personally observed sixes of such units show that the extreme limits are linked by a complete series of transi-

Illustrations Buder, loc. cit., Pl. XXIV, fig 1-5, Perfiliev, Jour. Microbiol (Russian), 1, 1911, 213, fig 1-5

#### Genus VI. Cylindrogloea Perfilier

(Jour. Microbiol (Russian), 1, 1914, 223) From Latin cylindera and Greek gloss, a glutinous substance.

Green sulfur bacteria, consisting of small ovoid to rod-shaped cells, growing in association with a filamentous, colorless, central bacterium, thus forming colonies of a cylindrical chape. Non-motile. The green component contains a chlorophylous pigment different from the common chlorophylls of green plants and from steriochlorophyll. Capable of photosynthesis in the presence of hydrogen sulfide, without depositing sulfur globules in the cells.

The type species is Cylindrogloca bacterifera Perfiliev.

 Cylindrogloea bacterifera Perfiliov. (Jour. Microbiol. (Russian), 1, 1914, 223.)
 From Latin bacter, rod and fero, to bear.

Individual green components ovoid to rod-shaped, about 0.5 to 1 by 2 to 4 microns, very similar to those of the comnlex Chlorobacterium symbioticum and Chlorochromatium agaregatum with which they may well be identical. The central filamentous bacterium is embedded in a slime capsule of considerable dimensions. This, in turn, is surrounded by a layer of green bacteria, usually one cell thick. The green organisms may form a very dense outer covering, or they may be more sparsely distributed over the mucus capsule The entire unit is again surrounded by a sizeable slime zone. Aggregates measure about 7 to 8 microns in width, and up to 50 microns in length; they are non-motile. Both components annear to be non-spore-forming.

Habitat; Mud and stagnant water containing rather high concentrations of hydrogen sulfide and exposed to light. Illustration: Perfiliev, Inc. cit., 213, for 6-11.

Perfiliev rightly emphasizes, as Buder had done for Chloronium mirabile, the provisional nature of thus using a generic designation for an apparently stable complex composed of two different organisms. It remains possible that the last three genera of symbiotic entities represent fortuitous combinations whose occurrence is conditioned by environmental factors If so, the generic terminology would be devoid of any tarenomic significance, and the green bacteria should be relegated to more appropriate genera. Indications suggestive of this state of affairs can be found in the literature; for example in Utermöhl's observation (Archiv f. Hydrobiel, Suppl. 5, 1925, 279) that the complex Chlorochromatium aggregatum may, especially in the presence of ovygen, disintegrate, whereupon the green constituents appear as small Pelodictyon aggregatum (Schmidlea Liteola) colonies.

#### ORDER II. ACTINOMYCETALES BUCHANAN.

(Jour. Bact., 2, 1917, 162)

Organisms forming elongated cells which have a definite tendency to branch. These hyphae do not exceed 1 5 microns and are mostly about 1 micron or less in diameter. In the Mucobacteriaceae the mycelium is rudimentary or absent; no spores are formed; the cells are acid-fast. The Actinomycetaceae and Streptomycetaceae usually produce a characteristic branching mycelium and multiply by means of special spores, oidtospores or couldia Special spores are formed by fragmentation of the plasma within straight or spiral-shaped spore-bearing hyphae; the oidiospores are formed by segmentation, or by transverse division of hyphae, similar to the formation of oidia among the true fungs, the conidia are produced singly, at the end of simple or branching conidiophores They grow readily on artificial media and form well-developed colonies The surface of the colony, especially in the Actinomycetaceae and Streptomucetaceae, may become covered with an aerial mycelium. Some form colorless or white colonies, whereas others form a variety of pigments. Some species are partially acid-fast. In relation to temperature, most are mesophilic, while some are thermophilic Certain forms are capable of growing at low ovegen tension. The Order as a whole is composed of saprophytic species, but also includes species that are parasitic and sometimes pathogenic on both animals and plants

Key to the families of order Actinomycetales.

I Mycelium rudimentary or absent, no spores formed. Acid-fast.

Famuly I Mycobacteriaceae, p 875.

II True mycelium produced

A. Vegetative mycelium divides by segmentation into bacillary or coccoid elements. Some species partially acid-fast

Family II. Actinomycetaceae, p 892.

B Vegetative mycelium normally remains undivided.

Family III. Streptomycetaceae, p. 929.

Among the recent systems of classification of this order it is sufficient to mention the following Baldace (Mycopart, 2, 1933, 42) divided the order Actinomycetales into two families (a) Mycobacteriaeceae Chester with two subfamilies, Leptotrickioideae Baldacci and Proactinomycoudeae Baldacci, each with five genera, and (b)
Actinomycetaeceae Buchanan, with two genera, Micromonospora and Actinomycetaeceae,
Krassilnikov (Ray fungi and related organisms, 1rd Akad. Nauk, Moskow, 1938)
divided the order into (a) Actinomycetaecae, with four genera, Actinomycet, Proactinomyces, Mycobacteriaecae, Mycobacteriaecae, with one genera, Micromonosporaecae, with one
genus, Micromonospora. Waksman (Jour. Bact., 29, 1940, 549) divided the order into
four families: Mycobacteriaecae, Proactinomycetaecae, Actinomycetaecae and Micromonosporaecae.

#### FAMILY I. MYCOBACTERIACEAE CHESTER \*

(Chester, Man. Determ Bact., 1901, 349; Proactinomycetaceae Lehmann and Haag, in Lehmann and Neumann, Bakt. Diag., 7 Aufl., 2, 1927, 674)

Completely revised by Prof G B Reed, Queens University, Kingston, Ontario, Canada, December, 1938, minor revisions, December, 1944, with a complete revision of Mycobacterium leprae and M. lepracmurium by Dr. John H. Hanks, Leonard Wood Memorial, American Leprosy Foundstion, New York, N. Y.

Glycerol broth: After S weeks, thick, white or cream-colored, wrinkled pellicle extending up the sides of the flask, no turbidity; granular or scaly deposit.

Dorset's egg slants: After 4 weeks. rather sparse, discrete or confluent. slightly raised, grayish-yellow growth with finely granular surface.

Glycerol egg slants: After 4 weeks. luxuriant, raised, confluent, gray to yellow growth, with granular surface. generally with nodular heaped-up areas,

Coagulated beef serum; After 4 weeks. thin, effuse, confluent, gray to yellow growth, with a very fine granular surface.

Glycerol beef serum: After 4 neeks. luxuriant, thick, raised, confluent, yellow to orange-yellow growth, with coarsely granular surface, generally with irregularly heaped-up areas.

Litmus milk Growth, but no change in the milk

Glycerol potato: After 4 weeks, luxuriant, raised, confluent, cream-colored 

and lactose not utilized (Merrill, Jour.

abnen

Bact., 20, 1930, 235, based on the examination of one strain). Optimum temperature 37°C

Optimum pH 7.4 to 80 (Ishmori, Ztschr f. Hyg , 102, 1924, 329); pH 60 to 65 (Dernby and Naslund, Biochem. Zeit , 132, 1922, 392).

Pathogenicity. Produces tuberculosis in man, monkey, dog and parrot. Experimentally, it is highly pathogenic for guinea pigs but not for rabbits, cats, goats, oven or domestic fowls.

mammalian Intermediate Griffith (Lancet, 1, 1916-17, 721; Jour. Path and Bact., 21, 1924, 54) has found aberrant types particularly in skin lesions of both man and ox, which are in certain characteristics intermediate between the human and the bovine varieties. He finds no evidence, however, that the one variety may change into the other.

Variation · Variation in colony structure of the two mammalian varieties,

comparable with that in other species, has been described by several authors, as Petroff et al. (Jour. Exp. Med , 60, 1934, 515), Birkhaug (Ann. Inst. Past, 67, 1933, 428), Kahn et al. (Jour. Bact, 25, 1933, 157), Uhlenhuth and Sieffert (Zeit Immun , 59, 1930, 187), Reed and Rice (Canad. Jour. Res., 5, 1931, 111), Smithburn (Jour. Exp. Med., 63, 1936, 95) and Shaffer (Jour. Path. and Bact., 40, 1935, 107). Several of these authors have found associated variation in cell structure and in virulence though Boquet (Compt. rend. Soc. Biol. Paris, 103, 1930, 290), Birkhaug (Ann. Inst. Past., 49. 1932, 630), and others, have failed to find differences in virulence. Reed and Rice (Jour. Immunol., 23, 1932, 385) found the S form to contain an antigenic substance lacking in the R form.

Antigenic structure: By agglutination, absorption of agglutining and complement fixation a distinction may be made between the mammalian varieties and Mycobacterium avium, but it has been impossible to distinguish, by these means, between the two mammalian varieties (Tullock et al., Tubercle, 6, Oct.-Dec, 1924, 18, 57 and 105; Wilson, Jour. Path. and Bact., 28, 1925, 69; Griffith, Tuberele, 6, May, 1925, 417; Rice and Reed, Jour. Immunol., 23, 1932, 385; Kauffman, Ztschr. f. Hyg., 114, 1932, 121). Tuberculins prepared from the human and the bovine varieties are ordinarily in--4'-- but Tewis

> 1931, r an-

aphylactic reactions.

Distinctive characters. Tubercle bacelle pathogenic for guinea pigs and rabnot for fowls. Mycobacterium tuberculosis var. hominis produces generalized tuberculosis in guinea pigs but not in rabbits. Mycobacterium tuberculosis var. boris produces generalized disease in both guinea pigs and rabbits. Growth of the human variety is enhanced by the addition of glycerol to most media. The growth of the bovine variety is not enhanced by the addition

of glycerol. The human variety generally develops vellow to red pigment on serum media, while the boying variety never produces pigment. Antigenically

the two varieties are not distinguishable. Source From tuberculous locione in man

Habitat. The cause of tuberculosis in man. Transmissible to rabbits and guinea niga.

1b. Mucobacterium tuberculosis var bouts Lehmann and Neumann. (Bovine tubercle bacilli. Th Smith Trans. Assoc. Am Phys. 11, 1896, 75: 13, 1898. 417. Jour Exp Med . 5, 1898, 451. Mucobacterium tuberculosis tynus batinus Lehmann and Neumann, Bakt Digg. 4 Aufl., 2, 1907, 550 ). From Laten boris, of the ox

Common name Bovine tubercle baaillire

Description from Th Smith (loc cit ) and Tonley and Wilson (Princip of Bact and Immun . 2nd ed . 1936, 315)

Rods which are shorter and plumper than the human type Range in size from 10 to 1,5 microns Very short forms are frequently intermixed with somewhat larger forms Stain regularly or pregularly. Acid-fast and acid-alcohol-fast, Gram-positive Less easily cultivated than the human variety

Nutrient agar · No growth

Giveerol agar colonies Small, pregular, with granular surface, no pigment,

Glycerol agar slant: After 4 weeks. thin, granular or effuse, confluent growth, Nutrient broth: No growth

Glycerol broth, After S weeks, thin grayish-white film, slightly nodular, no turbidity. Slight granular deposit

Dorset's egg alants: After 4 weeks, similar to var. hominis but generally poorer growth and no pigmentation

Glycerol egg slants. After 4 weeks, similar to Dorset's egg slants.

Congulated beef serum. After 4 weeks, thin, effuse, confluent, white to gray growth with very fine granular surface, Generally less luxuriant than in the human wariater

Giverni heef serum: After 4 weeks similar to plain beef serum.

Giverni potato: After 4 weeks, thin offuse groupsh growth

Litmus milk Growth, but no change in the milk

Ontimum temperature 37°C

Ontimum aH 58 to 69 (Ishimori Ztschr f. Hyg. 102, 1924, 329): 6 0 to 6 5 (Dernhy and Nashund, Biochem, Zeit 152, 1922, 392).

Pathogenicity: Produces tuberculosis in ox, man, monkey, goat, sheep, big, cat, parrot, cockatoo and possibly some birds of prev. Experimentally, it is highly nathogenic for rabbit and guinea nig, slightly nathogenic for dog, horse, rat and mouse not nathogenic for fowls

Variation See Mucobactersum tuberculosis var. hominis.

Antigenic structure. See Mucobacterium tuberculosis var. hominis

Distinctive characters See Mucobacterium tuberculosis var hominis

Source From tubercles in cattle

Habitat The cause of tuberculosis in cattle Transmissible to man and domestic animals More highly pathorenic for animals than the human type.

2 Mycobacterium avium Chester. (Tuberculose des oiscaux, Strauss and Gamaléia, Arch. Méd exp et Anat. path , 1891; Bacillus der Huhnertuberculose, Maffucci, Ztschr f Hygiene, 11. 1892, 449: Bacillus tuberculosis gal-Imarum Sternberg, Man, of Bact., 1893. 392. Mucobacterium tuberculosis arium Lehmann and Neumann, Bakt Diag , I Aufi . 1. 1896, 370, Bacillus tuberculosis arrum Kruse, in Flügge, Die Mikroorganismen, 3 Aufl , 2, 1896, 506; Mycobacterium arium Chester, Manual Determ Bact , 1901, 357, Mycobacterium tuberculosis typus gallingceus Lehmann and Neumann, Bakt Ding , 4 Aufl., 2. 1907, 553) From Latin aris, bird.

Common name: Avian tubercle has cillus.

Description from Strauss and Gamaléia (loc. cit.) and Topley and Wilson (Princip. of Bact. and Immun., 2nd ed., 1936, 315).

Rods resembling those of the bovine type of tubercle organism.

Nutrient agar: After 4 weeks, slight growth, offuse, translucent with fine granular surface.

Glycerol agar colonies: After 3 to 4 weeks, raised, regular, hemispherical, creamy or white colonies.

Nutrient broth: After 4 weeks, very slight viscous to granular bottom growth, no pellicle, no turbidity,

Glycerol broth: After 4 weeks, diffuse, turbid growth with a viscous to granular deposit.

Dorset's egg slants: After 4 weeks, confluent, slightly raised growth, with smooth regular surface.

Glycerol egg slants: After 4 weeks, luxuriant, raised, confluent, creamy to yellow growth with perfectly smooth surface.

Congulated beef serum: After 4 weeks, thin, effuse, grayish-yellow growth with smooth surface.

Glycerol beef serum: After 4 weeks, luvuriant, raised, confluent, yellow to orange-yellow or occasionally pale pink growth, with a smooth glistening surface.

Glycerol potato: After 4 weeks, luxuriant, raised, confluent, with smooth to nodular surface.

Litmus milk: Growth, but no change in the milk.

Carbohydrates: Fructose, arabinose and sucrose are utilized, glucose is slightly utilized, galactose and lactose are not utilized (Merrill, Jour. Bact., 20, 1930, 235, based on the examination of one strain).

Optimum temperature 40°C; range 30°

to 44°C (Bynoe, Thesis, McGill University, Montreal, 1931).
Optimum pH 6.8 to 7.3 (Bynoe, loc.

Optimum pH 6.8 to 7.3 (Bydoc, tot.

Pathogenicity: Produces tuberculosis in domestic fowls and other birds. In pigs it produces localized and sometimes disseminated disease. Experimentally in the rabbit, guinea pig, rat and mouse it may proliferate without producing macroscopic tubercless-tuberculosis of the Yersin type. Man, ox, goat, cat, horse, dog and monkey are not infeat,

horse, dog and monkey are not infected, Variation: Winn and Petroff (Jour. Exp. Med., 57, 1933, 239), Kahn and Schwartzkopf (Jour. Bact., 25, 1933, 157), Birkhaug (Ann. Inst. Pasteur, 54, 1935, 19), Reed and Rice (Canad. Jour. Res., 5, 1931, 111) and others, have shown variation to follow the course described for many species. Winn and Petroff have separated four colonial types; smooth, flat smooth, rough, deep yellow smooth. These also differ in chemical and physical properties. The smooth form exhibited the greatest degree of virulence, the flat smooth a lower virulence, while the chromogenic smooth and the rough were relatively benign. Some authors have failed to demonstrate this difference in virulence. The above description applies primarily to the smooth

form.

Antigenie structure: By agglutination, absorption of agglutinins and complement fixation Mycobacterium arium may be distinguished from other members of the genus (Tullock et al., Tubercle, 6, 1924, 18, 57 and 105; Wilson, Jour. Fath. and Bact., 28, 1925, 69; Mudd, Proc. Soc. Exp. Biol. and Med., 25, 1925, 593, and others). Furth (Jour. Immunol, 12, 1926, 273) and Shaffer (Jour. Path and Bact., 40, 1935, 107) on this basis divided Mycobacterium arium into 1 or 2 subgroups.

Distinctive characters: Tuberele lacilli pathogenic for fouls, not for guines pigs or rabbits. Culturally distinguished from the mammalian types by the absence of pellicle formation in fluid media and the habit of growth on most colid media. Antigenically distinguished from other species.

Source: From tubercles in fowls, widely distributed as the causal agent of tuberculosis in birds and less frequently in pigs. Habitat The cause of tuberculesis in chickens. Transmissible to pigeon, other birds, mouse, rabbit and pig

3 Mycobacterium paratuberculosis Bergey et al. (Darmtuberculose bacillen, Johne and Frothingham, Deutsch. Zischr. Tiermed., 21, 1895, 438; Pseudotuberkulese bacillen, Bang, Berl. terärzit. Wehnschr, 1906, 759, Bacillus of Johne's Disease, M'Fadycan, Jour Comp Path, 20, 1907, 48, Twort, Proc Roy Soc, B, 33, 1910, 156; Bergey et al, Manual, 1st ed., 1923, 374) From M L paratuberculosis, of the disease paratuberculosis.

Common name. Johne's bacillus

The organism from a similar disease in sheep is probably identical though more difficult to cultivate (Dunkin and Balfour-Jones, Jour Comp Path , 48, 1935, 236)

Description from M'Fadycan (loc cit) and Twort and Ingram (A Monograph on Johne's Disease, London, 1913)

Plump rods, 1 0 to 2 0 microns in length, staining uniformly, but occasionally the longer forms show alternately stained and unstained segments Non-motile Acid-fast

The organism is difficult to cultivate and, in primary cultures, has only been grown in media containing dead tuberele bacilli or other dead acid-fast bacteria (Boquet, Ann Inst Pasteur, 37, 1928, 495). In a few instances cultures have been acclimatized to a synthetic medium free from added dead bacteria (Dunkin, Jour Comp Path and Therap, 48, 1933, 157; Watson, Canad. Pub. Health Jour. 25, 1935, 265.

Colonies on glycerol agar containing heat-killed Mycobacterium phles: After 4 to 6 weeks, just distinguishable, dullwhite, raised, circular colonies.

Colonies on Dorset's glycerol egg containing heat-killed Mycobacterium phlei. After 4 to 6 weeks, minute, dull-white, raised, circular, with a thin, slightly irregular margin. Older colonies become more raised, radially striated or irregularly folded and dull yellowish-white

Dorset's glycerol egg containing sheep's brain and heat-killed Mycobacterium phlei Growth slightly more luvuriant. Glycerol broth containing heat-killed

Glycerol broth containing heat-killed Mycobacterium phlei: Thin surface pellicle which later becomes thickened and folded.

Dorset's synthetic fluid containing heat-killed Mycobacterium phlei: As on glycerol broth with Mycobacterium phlei. Pathogenicity Produces Johne's dis-

ratagementy Produces Joine 8 uscase, chronic diarrhea, in cattle and
sheep Experimentally it produces a
similar disease in bovine animals, sheep
and goats. Guinea pigs, rabbits, rats
and mice are not infected. Very large
doese in laboratory animals produce
slight nodular lesions comparable with
those produced by Mycobacterium phlei.
Antigenes structure Johnn, prepared

Antigene structure Johnn, prepared as tuberculin, gives positive reactions in cattle with Johne's disease. According to M!Fadyean et al. (Jour Comp Path, and Therap., 29, 1916, 62) tuberculous animals may also give a reaction. Plumb (Den. Kong. Vet. Landbohigiskol Chen. Kong. Vet. Landbohigiskol Arssk., 1925, 63) has shown that a reaction may be produced in animals sensitived to avian tuberculin and that avian tuberculin causes a reaction in some animals infected with Johne's landling.

Distinctive characters A small acidfast bacillus producing characteristic lesions in cattle and growing only in the presence of dead acid-fast bacilli.

Source From the intestinal mucous membrane of cattle suffering from chronic diarrhea Apparently an obligate parasite.

Habitat The cause of Johne's disease, a chronic diarrhea in cattle. The bacteria are found in the intestinal mucosa. Not pathogenic for guinea pigs or rabbits.

4 Mycobacterium Ieprae (Armauer-Hansen) Ichmann and Neumann. (Racillus Ieprae Armauer-Hansen, Norsk Mag Jaegeviden-k., 9, 1874, 1; Arch. f. path Anat. u. Physiol, 79, 1879.

32; Nord. Med. Ark., 12, 1880, 1, Quart. Jour. Micro. Sci., 20, 1880, 92; Coccothrix leprae Lutz, Dermatol. Stud. 1, 1886, quoted from DeToni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1889, 944; Lehmann and Neumann, Bakt. Diag , I Aufl., 2, 1896, 372; Discomyces leprae Neveu-Lemaire, Précis Parasit Hum., 5th ed , 1921, 27; Sclerothrix leprae Vuillemin, Encyclopédie Mycologique, Paris, 1, 1921, 135; Mycobacterium leprae hominus Lowe, Internat Jour. Leprosy, 5, 1937, 312) From Greek lepra, leprosy

Common name: Leprosy bacillus.

Armauer-Hansen (loc. cit ) was the first to observe the bacilli in the tissues of lepers The disease is now known as Hansen's disease. The bacilli occur in enormous numbers in lepromatous (nodular) cases of the disease and sparsely in the neural form. The present bacteriological means of identification depend on: (a) acid-fast staining, and (b) failure of the organism to grow in bacteriological media or in laboratory animals. Heated suspensions of the bacilly (obtained from nodules) produce a positive lepromin reaction in 75 to 97 per cent of normal persons and of neural cases of leprosy, but usually produce no reaction in lepromatous individuals (Mitsuda: See Havashi, Int. Leprosy, 1, 1933, 31-38) The failure of lepromatous persons to respond to injected leprosy bacılli constitutes a lundamental criterion for testing the validity of microorganisms such as other acid-fast or diphtheroid cultures which can at times be recovered from leprous tissues by inoculation of bacteriological media.

Many organisms have been isolated from leprous tissues, some of which are acid-fast and have been styled Myrobacterium leprae The strains which have been adequately studied have proven to fall into the saprophytic groups (see No. 11, Mycobacterium spp ) Hanks (Int. Jour. Leprosy, 9, 1941, 275-298) found that acid-fast cultures of this

type, as well as the diphtheroids which also have repeatedly been isolated from leprosy, were recoverable only from lesions located proximally with respect to open ulcers in the skin.

Description of organisms seen in leprosy tissue from Armauer-Hausen (loc. cit.) and Topley and Wilson (Princip. Bact. and Immun., 2nd ed, 1936, 316).

Rods: 03 to 05 by 1 to 8 microns, with parallel sides and rounded ends, staining evenly or at times beaded. When numerous, as from lepromatous cases, they are generally arranged in clumps, rounded masses or in groups of bacilli side by side. Strongly acid-fast. Grampositive.

Pathogenicity: The communicability of leprosy from man to man is accepted (Rogers and Muir, Leprosy, 2nd ed, Baltimore, 1910, 260 pp.). Experimental transmission to humans or to animals has not been successful.

Source: Human leprous lesions. la the lepromatous form of the disease bacilli are so abundant as to produce stuffed-cell granulomas; in the tuberculoid and neutral lesions they are rare.

Habitat: Obligate parasite in man Confined largely to the skin (especially to convex and exposed surfaces) and to peripheral nerves. The microorganisms probably do not grow in the internal organs.

5 Mycobacteriun lepraemurlum Marchoux and Sorel. (Bacillus der Rattenlepra, Stefansky, Cent. f. Bakt., I Abt, Orig., \$3, 1903, 481; Mycobacterium leprae murium Marchoux and Sorel, Ann Inst. Past , 26, 1912, 700; Bacellus leprae murium Muir and Henderson, Indian Jour. Med. Res , 15, 1927, 15.)

Mycobactersum pulesforme Marchous (Ann Derm , 1921, No. 21 and Ann Inst. Past., 57, 1923, 348) from leprosylike lesions in a man from Hayti is thought by the author to be identical with Mycobaclerium lepraemurium Common name: Rat leprosy bacillus

Rods. 3 0 to 5 0 microns in length with slightly rounded ends. When stained, often show irregular appearance. Strongly acid-fast Gram positive

Like the human leprosy bacillus, this organism has not been cultivated in vitro; but can be passed experimentally through rats and some strains of mice

Distinctive features The heat-kulled bacilli produce lepronin reactions in lepratomous humans. The bacilli from lesions are not bound together in clumps, rounded masses and palsades as in human lesions. For further details see review by Lowe (Internat Jour Leprosy, 5, 1937, 310 and 463)

Source. An endemic disease of rats in various parts of the world, having been found in Odessa, Berlin, London, New South Wales, Hawaii, San Francisco and elsewhere

Habitat The natural disease occurs chiefly in the skin and lymph nodes, causing induration, alopecia (loss of hair) and eventually ulceration

6. Mycobacterium piscium Bergey et al (Bacillus tuberculosis piscium Dubard, Bull. acad. de méd, 3 sér, 38, 1897, 580; Bataillon, Dubard and Terre, Compt rend Soc Biol., 4, sér. 10, 1897,

446; Bergey et al., Manual, 1st ed, 1923, 375) From Latin piscis, fish Description from Bataillon et al. (loc cit.) and Aronson (Jour. Inf. Dis, 39, 1925, 319).

Slender rods, occurring singly and in threads, occasionally showing branching Acid-fast. Non-motile. Gram-positive

Agar colonies: Small, circular, white, moist, with lobate margin and fine granular surface.

Agar slant: Scant, white, moist, creamlike. Glycerol agar colonies: Thin, flat,

smooth, glistening, yellow.

Dorset's egg medium: Flat, smooth, moist, greenish

Broth: Thin pellicle, with flocculent sediment.

Litmus milk: Thickened. No coagulation. Slightly alkaline.

Potato White, warty, butyrous colonies.

Carbohydrates: Utilizes glucose and fructose but not sucrose, lactose, arabinose or galactose (Merrill, Jour Bact, 20, 1930, 235, based on examination of one strain).

Antigenic structure: By agglutination and complement fivation (Mudd, Proc. Exp Biol. and Med., 28, 1925, 569; and Furth, Jour. Immunol, 18, 1929, 286) Mycobacterium piestum has been distinguished from Mycobacterium friedmanni, Mycobacterium ranae and probably Mycobacterium mintum From the limited number of cultures examined it is not evident whether this is due to species or strain specificity.

Pathogementy: Experimentally produces tubercles in carp, frog and lizard, but not pathogenic for rabbit, guines pig or birds (Dubard, Rev. de la Tuberc, \$6, 1898, 13). Not pathogenic for salt water fish except cels (Betegh, Cent. f. Bakt., I Abt., Orig., \$3, 1910, 374; \$4, 1910, 211)

Distinctive characters: Mycobacterium pictum, Mycobacterium marium, Mycobacterium rane, Mycobacterium thammophoes and Mycobacterium field-manni constitute a closely related group-possibly one species. They differ from other members of the genus in their pathogenicity for cold-blooded animals, their failure to survive 80° for an hour, their failure to survive 80° for an other, their inshity to diffice sortifications of the survive 10° for an other inshity to diffice sortification.

Mycobacterium marinum is distinguished by its diffuse growth in broth, and production in milk and deep yellow to orange pigmentation on most media. The other species grow in broth as a pellicle and render milk alkaline. Mycobacterium picturium, Mycobacterium renderterium renderterium renderterium renderterium renderterium renderterium renderterium thempohees and Mycobacterium themannii may be distinguished from each other by their habit of growth on solid media. But relatively few cultures have been studied

and the reports in certain important respects are conflicting, especially concerning pigmentation and utilization of carbohydrates. Aronson, Mudd Furth found them to differ antigenically. but too few cultures were used to distinguish between species and strain specificity.

Source: From tubercles in carp.

Habitat: The cause of nodule and tumor-like formations in carp (Ciprinus carpio). Infectious for carp, frogs, lizards. Not infectious for guinea pigs and niccons.

7. Mycobacterium marinum Aronson. (Jour. Inf. Dis., 39, 1926, 315.) From Latin marinus, marine.

Description from Aronson (loc. cit.).

In lesions, short, thick, uniformly staining organisms are seen frequently occurring in clumps, while long, thin, beaded or barred rods are scattered more discretely In cultures the organisms have the same appearance. Non-motile. Acid-fast and acid-alcohol-fast. Grampositive

Agar slant (slightly acid): In five to seven days, moist, glistening, elevated colonies, becoming lemon-vellow.

Gelatin. Not liquefied

Agar colonies: In 5 to 7 days, smooth, moist, slimy, lemon-vellow, later orangecolored.

Glycerol agar colonies: In 11 to 18 days, grayish-white, moist, clevated with irregular margins. Old growths lemonvellow and still later orange-colored. Dorset's and Petroff's egg media

Similar to growth on glycerol agar but more luxuriant.

Broth and glycerol broth: Growth 18 diffuse, no pellicle formed.

Litmus milk Acidified and coagulated. Indole not formed.

Nitrites not produced from mirates.

Carbohydrates Utilizes arabinose and fructose, fails to utilize sorbital and galactose (Gordon, Jour. Bact , 54, 1937, 617).

Acrobic, facultative.

Ontimum temperature 18° to 20°C. Fails to survive 60°C for 1 hour, fails to grow at 47°C (Gordon, Jour, Bact, 34, 1937, 617).

Pathogenicity: Experimentally infects salt water fish, goldfish, frogs, mice and nigeons, but not rabbits or guinea pigs.

Antigenic structure: By agglutination and complement fixation distinguished from Mucobacterium ranae, Mucobacterium friedmannii, and probably Mycobacterium piscium (Mudd, Proc. Soc. Exp. Biol, and Med., 23, 1925, 569; Furth, Jour. Immunol., 12, 1926, 286). See Mucobacterium piscium.

Distinctive characters : See Mycobacte-

rium piscium,

Source: From areas of focal necrosis of the liver of sergeant majors (Abudefduf mauritii), croakers (Micropogon undulatus ) and sea bass (Centropristes striatus). Habitat: Causes spontaneous tubercu-

losis in salt water fish.

8. Mycobacterium ranae (Küster) Bergey et al. (Kuster, Munch, med. Wehnschr., 52, 1905, 57; Bergey et al., Manual, 1st ed., 1923, 374.) From Latin rana, frog.

Description from Kuster (loc cit), Bynoe (Thesis, McGill University, Montreal, 1931) and Aronson (Jour. Inf. Dis,

44, 1929, 222). Slender rods, 0.3 t 0.5 by 2 to 8 mierons, smaller in ald cultures. Uniformly acid-fast in cultures 2 weeks old or older. In younger cultures the stareing is irregular, many organisms are not acid-fast. Non-motile. Gram-positive.

Gelatin stab: No liquefaction.

Agar colonies: Irregular, raised colomes, 1 to 3 mm in diameter with most surface, later becoming glistening coarsely granular.

Agar slant: Thick, spreading, glistening. In old cultures dry and scaly. Putrid odor Grayish-white.

Glycerol agar colonies · Similar to gelatin colonies but slightly creamy and becoming dry and wrinkled in old cultures. Dorset's cgg medium: Spreading, raised, glistening, later wrinkled

Loeffler's medium: Similar to Dorset's

Litmus milk: Becomes alkaline

which breaks up early and settles

Broth. Slightly turbid, with slight sediment.

Potato. Scanty, grayish growth, raised with a warty surface.

Indole not formed.

Nitrates are produced from natrates.

Carbohydrates: Glucose, fructose and arabinose are utilized; sucrose, lactose and galactose not utilized (Merrill, Jour. Bact. 20, 1930, 235) Fructose, mannutol and trehalose are utilized; sorbitol, arabinose and galactose are not utilized (Gordon, Jour. Bact. 54, 1937, 617)

No H.S formed.

Optimum temperature 28°C (Kuster), 37°C (Bynoe).

Optimum pH 66 to 73, range 40 to 100

Antigenie structure. By agglutination and complement fivation Mycobacterium ranae may be distinguished from Mycobacterium piecium and Mycobacterium priecium and Mycobacterium priedimanii (Mudd, Proc Soc Exp Biol. and Med, 23, 1925, 569, Furth, Jour Immunol., 18, 1926, 286). See Mycobacterium piecium

Pathogenicity. Experimentally causes tuberculosis in frogs, lizards, turtles, not pathogenic for rabbits, guinea pigs, rats or mice.

Distinctive characters See Mycobacterium piscium.

Source. From the liver of a frog.

Habitat: In a group of 215 cultures belonging to the genus, isolated from soils, Gordon (Jour Bact, 31, 1937, 617) found 65 to sufficiently resemble Mycobacterium ranae to indicate at least a very close relationship. If they prove to be identical, the species is widely distributed.

Mycobacterium thamnopheos Aronson (Jour. Inf. Dis., 44, 1929, 222)
 I'rom Thamnophis, a genus of snakes.

Tuberculhacillen bei Schlangen Sibley Arch. f. nathol Anat u. Physiol. 116, 1889, 104 (Mucobacterium tranidana tum (sic) Bergey et al . Manual, 1st ed .. 1923 376) is probably identical but the descriptions are too meager to be conclusive Acid-fast bacilli described by Gibbes and Shurley (Amer. Jour. Med. Sci 100, 1800, 145) as the cause of tuberculosis in boas and nythons; by Shattock (Trans Path, Soc., London, 53, 1902, 430) and by you Hanseneann (Cent f Bakt I Abt Orig. 54, 1903. 212) as consing tuberculosis in a Puthan molutus are possibly identical but the descriptions do not permit us to draw any conclusions. According to Aronson. similar organisms isolated from nathological lesions in boa constrictors and Caluber catenifer differ antigenically from Mucobacterium thamnopheos.

Description taken from Aronson (loc. cit.) and Bynoe (Thesis, McGill University, Montreal, 1931).

Slender rods 0.5 by 4 to 7 microns, frequently slightly curved, beaded and barred forms frequently occur. Nonmotile Acid-fast in cultures of 4 days or older, in younger cultures some organisms are not acid-fast. Not alcoholfast Grism-positive.

Gelatin stab: Growth occurs along the '
line of inoculation. No liquefaction

Agar colonies 0 5 to 1 mm in diameter, irregular, raised, moist and glistening.

Glycerol agar. Spreading, raised, dry, nale pink to buff growth.

Glycerol broth A thin pellicle appears in 5 to 6 days, gradually becomes thicker and falls as a sediment.

Dorset's egg medium. Raised, moist, pinkish growth after 10 days, later becoming salmon-colored.

Loeffler's serum: Small, raised, convex, dry growth

Litmus milk: Alkalıne

Glycerol potato: Raised, hemispherical, dry and granular growth.

Indole not produced.

Nitrates: Not reduced by 2 strains,

reduced by 1 strain (Aronson); slightly reduced (Gordon): not reduced (Bynoe).

Carbohydrates: Utilizes fructose, mannitol and trehalose; fails to utilize arabinose, sucrose, galactose and sorbitol (Gordon, Jour. Bact., \$4, 1937, 617).

Temperature relations: Fails to survive 60°C for 1 hour, fails to grow at 47°C (Gordon): good growth at 25°C, no growth at 37°C (Aronson); optimum for growth 25°C, range 10° to 35°C (Bynoe).

Range of pH · 6.6 to 7.8 (Aronson); optimum 7.3 to 8.0, range 50 to 11.0 (Bynoe).

Pathogenicity · Experimentally produces generalized tuberculosis in snakes. frogs, lizards and fish but not pathogenic for guines pigs, rabbits or fouls.

Antigenic structure; By agglutination and absorption of agglutinins Mycobacterium thamnopheos may be distinguished from Mucobacterium marinum, Mycobacterium friedmanni and Mycobacterium ranae. See Mycobacterium piscium.

Variation According to Bynoe and Wyckoff (Amer. Rev Tub., 29, 1934, 389) S and R forms may be distinguished by colony structure and individual cell arrangement.

Distinctive characters: See Mycobacterium piscium.

Source: From the lungs and livers of garter snakes (Thamnophis sirtalis).

Habitat · Present as a parasite in the garter snake and possibly other coldblooded vertebrates.

10. Mycobacterium friedmannil Hol-(Schildkroten tuberkelbacillus, land. Friedmann, Cent f Bakt, 1 Abt, Orig., \$4, 1903, 647; Bacillus friedmanss (sic) Holland, Jour. Bact., 5, 1920, 218; Mycobacterium friedmansi Holland, ibid; Mycobacterium chelones Bergey et al., Manual, 1st ed., 1923, 376.) Named for Dr. Friedmann, who isolated this organiam.

Common name. Turtle bacillus. Description from Friedmann cit.) and Aronson (Jour Inf. Dis , 44, 1929, 222).

Slender rods: 0.2 to 04 by 0.5 to 5 microns. Beaded forms are common. Acid-alcohol-fast in young cultures but in cultures two weeks old generally there are many non-acid-fast rods. Non-motile. Gram-positive.

Gelatin stab: White surface growth, scanty growth along the line of stab. No liquefaction.

Agar colonies: I to 3 mm in dismeter, irregularly round, raised, moist, glistening, white,

Giveerol agar slants: Thick, spreading growth, at first moist, later granular, vellowish-white (Friedmann), olive-gray (Bynoe); white (Aronson).

Glycerol broth : Thick wrinkled pellicle after two to three days growth, later some membranous sediment. Gravishvellow (Friedmann): gravish-white (Bynoe).

Dorset's medium: Spreading, egg raised, slightly moist, pale buff.

Loeffler's serum: Scant growth, raised, dry, crumb-like. Litmus milk: Slightly alkaline after

10 days growth. Glycerol potato: Thick, wmnLied, gray

after 2 days growth. Indole not formed.

Carbohydrates: Glucose, fructose and arabinose utilized, sucrose slightly utilized, galactose and lactose not utilized (Merrill, Jour. Bact, 20, 1930, 235). Arabinose not utiliz d (Gordon, Jour. Bact., 34, 1937, 617)

Optimum temperature 25° to 30°C.

Pathogenicity: Experimentally produces tubercles in most species of coldblooded animals, possibly in guinea pigs but not in other warm-blooded animals.

Variation: According to Gildemeister (Cent. f. Bakt., I Abt., Orig., 88, 1921, 513) S and R types may be distinguished on glycerol agar. The S grows as smooth, moist, glistening, convex colonies; the R as flat, dry, spreading colonies. Wykoff (Amer. Rev. Tub., 29, 1934, 289) has shown a difference in the form of cell division and corresponding cell arrangement of the two types.

Distinctive characters: See Mucobactarrum miraium Source From the lungs of turtles in

the Berlin aquarium.

Unhitat . A parasite in turtles and rosably sparingly distributed in soils. Gordon (Jour. Bact. \$4, 1937, 617) found 65 out of 215 call cultures of members of the gamus to closely resemble this species.

11 Myrobacterium sun. (A miscellancous group many of which have been spectreetly identified as Mucabacterium Innes Lehmann and Neumann

Clegg (Phil. Jour. Sci., 4, 1909, 77 and 403) Duval (Jour. Exp. Med . 12, 1910. 619) Duyal and Wellman (Jour Inf Dis . 11 1912, 116). Currie, Brinckerhoff and Hollmann (Pub Health Ren., 25, 1910. 1173) and others have described as Mucobacterium lenrae a group of organisms solsted from leprosy lesions evidence, summarized by McKinley (Medseine, 15, 1934, 377), points to the conclusion that these organisms are not nathoconic and not the causal agent of lenrosy They cannot therefore be included under Mucobacterium leprae as defined above

Thomson (Amer. Rev. Tub. 26, 1932. 162), Gordon (Jour. Bact., \$4, 1937, 617). and Gordon and Hagan (Jour Bact., 56. 1033, 39) recently separated the saprophytic members of the genus Mucobacterium into three main groups and several subgroups. Species names as here defined have been added to the key as follows \*

Group I. Fail to survive 50°C for 1 hour. Grow at 47°C. a. Utilizes arabinose,

Mycobactersum lacticola. b. Unable to utilize arabi-

hose Mucobneterium sp.

Group II Fail to survive 60°C for 1 hour. Do not grow at 47°C

a Unable to utilize sorbital I Ilnable to utilize arab. ínoso

> Mucobaeterium vanae Mucobacterium thamnonhens.

Mucobacterum sp.

2 Utilize arabinose Muchaeterium mar. inn

Murobacterium sp. b Utilizes sorbital

Mucobacterium san

e Unable to utilize most carbohydrates Mucobacternum fried-

> mannei. Mucobacterium sn.

Group III Survive 60°C for 1 hour Grow at 47°C

a litalizes orabinose

Mucobacterium nhles b. Unable to utilize arabi-

nose. Mucobacterium sp.

In this study Gordon and Hagan included many recently isolated soil forms. named santophytic species nathogens for cold-blooded animals and 19 cultures. from various collections, which bore the name Mucobacterium leprae. Of these so-called Mucobacterium leprae, six belong to Group I which corresponds with Mucobacterium lacticula and includes many soil forms, two belong to Groun Ha which includes Mucobacterium range. Mucobacterium thamnopheos and a number of undefined soil forms, while eleven belong to Group IIb. The latter group includes a number of soil cultures but no other defined species.

In the several groups to which so-called Mucobacterium leprae stmins belong. some appear to be indistinguishable from soil forms, others are distinguished by habit of growth, utilization of carbobydrates or by pigmentation

12 Mycobacterium lacticola Lehmann and Neumann. (Bakt. Diag , 2 Aufl., 2. 1899, 409.) From Latin lac, lactis, milk and colo, to dwell; hence, a milk dweller.

From the fact that Lehmann and Neumann (loc. cit., 411) refer to the binomial Bacillus friburgensis Korn, it is evident that the species name friburgensis (see Appendix) published the same year (1899) has priority over the species name lacticola. However, since it has never been used with the broad meaning given Mycobacterium lacticola by Lehmann and Neumann in the original description, it is not substituted for the more commonly used Mycobacterium lacticola in this edition of the Manual.

Description from Lehmann and Neumann (loc. cit) and Jensen (Proc. Linnean Soc. of New So. Wales. 59, 1934, 19).

Slender rods: 0.5 to 0.7 by 2 to 8 microns in young cultures, in older cultures the rods are shorter and frequently coccoid in shape. Curved and irregular forms occur occasionally. Branched forms, if they occur, are very rare Staming is generally uniform but slight beading occurs occasionally. Strongly acid-fast except organisms from glucose-containing media which are sometimes only faintly acid-fast. Gram-positive

Gelatin colonies. Similar to those on agar.

Gelatin stab: Filiform growth in stab.

Agar colonies: Convex, glistening, with entire margins, at first smooth but after 10 to 14 days growth folded or wrinkled Opaque, at first white, after 2 or 3 days growth becomes yellow

Glucose agar Similar to agar but more rapid growth and less intensely pigmented.

Glycerol agar slants Spreading, moist, wrinkled, pale cream-colored to yellow.

Nutrient broth Diffuse growth, later with yellowish pellucle

Litmus mulk. Small white granules of growth at the surface, later a dry yellowish pellicle. After some weeks' growth the milk becomes alkaline and clear No coagulation Dorset's egg medium. As on glycerol agar.

Coagulated serum: As on glycerol agar. Potato: Spreading, raised, wrinkled growth, pale yellow to orange.

Long's medium lacking glycerol: No growth. Long's medium with 5 per cent glycerol: Acid formed. (Thomson, Amer. Rev. Tub., 26, 1932, 162.)

Indole not formed.

Nitrates: Reduced, doubtful (Jensen). Carbohydrates: Clucose, fructuse, arbinose and galactose are utilized; lactee is not utilized; sucrose is not utilized; sucrose is not utilized; sucrose is not utilized by 1 strain, (Mycobacterium friburgensus) (Merrill, Jour, Bat, 20, 1930, 235). Sorbitol, ambinose, galactose, trehalose, mannitol and fructose are utilized; sucrose is not utilized (Gordon, Jour. Bact., 24, 1937, 617).

Optimum temperature 37°C, maximum temperature for growth 52°C, minimum 15° to 18°C. Fails to survive 60°C for 1 hour, grows at 47°C (Gordon, Jour. Bact., 54, 1937, 617; Gordon and Hagan Jour. Bact., 59, 1938, 93

Optimum pH 6.8 to 7.2. Limits for growth 4.5 to 100.

Distinctive characters: Saprophytic acid-fast organism. Grows rapidly on most media, develops a yellow or onneg pigmentation after 3 to 4 days grouth. Fails to grow on Long's medium lacking glycerol and produces acid when slycerol is present. Fails to survive 60°C for an hour, grows at temperatures as high as 4°C.

Variation. Lehmann and Neumann (Bakt. Diag., 2 Aufl., 2, 1899, 408) and Haag (Cent. I Bakt., II Abt., 71, 1927, 1) describe three forms: a flat smooth form, a moist, slimy, smooth form and a dry, moist, proceedings. The two former

nith R

tic of Mycovacterian. Mycobacterium berolinensis, Mycobacterium butyricum and Mycobacterium graminit which in turn correspond with S and I types of other members of the genu Schwabacher (Spec. Rep. Ser, Med. Res Coun., London, No. 182, 1933) finds a difference in the arrangement of the individual cells of the S and R types.

Source From butter, plant dust, cow

manure,

Habitat: Gordon (four Bact, 34, 1937, 617) found 1 culture isolated from nasal evudate, 1 from bovine lymph gland and 94 isolated from soil, out of a group of 215 soil cultures belonging to the genus, to be either identical with or very closely related to this species I fitness etams are valid members of the species, Myobacterium Institucia is widely distributed in soil, dust, dury products, etc

13 Mycobacterium phlei Lehmann and Neumann (Timotheebacillus of Grasbacillus I, Moeller, Therapeutischen Monatshoften, 12, 1828, 607, Moeller, Deut med. Wehnschr, 24, 1828, 366, Lehmann and Neumann, Bakt Diag, 2 Aufl. 2, 1829, 411, Mycobacterium moelleri Chester, Manual Determ Bact, 1901, 388, Sclerothriz phlei Vuillemin, Encyclopéde Mycologique, Pans, 2, 1931, 160) From M. I. Phleim, a genus of grasses

Description from Moeller (loc cit ) and Jensen (Proc Linnean Soc New So Wales, 59, 1934, 32)

Slender rods 0 2 to 0 5 by 1 to 4 merons, sometimes club-shaped, frequently beaded, rarely branched Strongly acid-fast and acid-alcohol-fast in cultures older than 2 to 3 days, in younger cultures there are generally many non acid-fast cells Non-mottle. Gram-positive

Gelatin colonies Small, 0.5 to 1 mm in diameter, irregular, raised, moist and glistening, finely granular, orange Gelatin stab Filiform, opaque, orange

No liquefaction.

Agar colonies Similar to gelatin colonies, yellon to orange. Agar slant. Spreading, raised, dry with

roughened granular surface, yellow to orange

Broth Turbid, with yellow pellicle. Dorset's egg medium: Spreading, raised, dry, orange. Loeffler's serum · Similar to Dorset's egg medium, creamy to yellow.

Glycerol broth: Thin transparent pellicle, later becoming thickened, rough, wrinkled and yellow to pink, still later a flaky sediment.

Latmus milk: Yellow flocculi on surface, slowly becomes alkaline. No coagulation.

Potato: Thick, dry, yellow, adherent growth.

Long's medium lacking glycerol: Abundant growth Long's medium with 5 per cent glycerol. No acid formed (Thomson, Amer Rev Tub, 26, 1932, 162).

Nitrites are produced from nitrates. Indole not formed.

Carbohydrates Glucose, fructose, arabnose, trehalose, mannitol and galactose are utilized; sucrose and lactose are no utilized (Merrill, Jour Bact., 20, 1930, 235, Gordon, Jour. Bact., 34, 1937, 617)

Temperature relations Survives 60°C for 1 hour, grows at 47°C (Thomson, Amer. Jour Tub., 20, 1932, 162); optimum for growth 37°C, range 20° to 58°C (Bynce)

Optimum pH 68 to 7.3; range 5.5 to 100

Pathogenicity The injection of large numbers of organisms into guinea pigs results in a local abscess of a few weeks duration, occasionally small abscesses develop in the regional lymph glands or the visceral organs According to Majer (Cent f Bakt, I Abt, 26, 1879, 331) and others, the injection of the organisms along with butter or other fat increases the pathological reaction

Variation Hang (Cent f Bakt, II bbt, 71, 1927, 1) and Bynor (Thesis, McGill University, Montreal, 1931) find two or three colony types an R form which fits into the description of the species given above and an S type which grows as a perfectly smooth, raised, mosts, glistening colony with an entire margin. Cooper (Jour In Dis. 54, 1934, 230) distinguished pigmented and non-pigmented types. Distinctive characters: Saprophyti acid-fast organism, grows rapidly on most media. Shows yellow pigmentation as soon as growth is visible. Grows well on Long's medium lacking glycerol and fails to produce acid when glycerol is present. Survives CO'C for 1 hour and grows at 47°C.

Source: Originally isolated from hay and grass. Frequently found in soil, dust and other sources. Out of 215 cultures of the genus recovered from soils by Gordon (Jour. Bact., 34, 1937, 617) Mycobacterium phiei was isolated on 22 occasions. The same author reports 3 cultures of a closely related from to identucal organsum recovered from bovine lymph glands, I recovered from bovine skin and I recovered from a hen's spleen.

Habitat: Widely distributed in soils, dust, hav, etc.

Appendix I: The following saprophytic species have been placed in this genus. Their relationships are not clear. Some are related to or possibly identical with Mucobacterium latituda

Mycobacterium album Söhngen. (Cent. f. Bakt., II Abt., 57, 1913, 599.) From garden earth

Mycobacterium bekken: Bekker. (Antonie van Leeuwenhoek, 9, 1943, 81; abst. in Cent. f. Bakt, I Abt., Orig, 149, 1944, 500.) From urine.

Mycobacterium berolinense Bergey et al.
(Tuberkelahnlichen Bacillen, Rabinowitsch, Ztschr f. Hyg., 26, 1897, 90;
Mycobacterium lacticola & perrugosum
Lehmean and Neumann, Bakt. Dug., 2
Aud., 2, 1899, 410; Mycobacterium lacticola perrugosum Hang, Cent f. Bakt.,

includes both the Tuberkelahnlichen Bacillen of Rabinowitsch and the Butter Bacillus of Petri. From butter.

"in

Mycobacterium butyricum Bergey et al. (Butter Bacillus, Petri, Arb. kaiserl. Gesundheitsamte, 14, 1898, 1; Bergey et al., Manual, 1st ed., 1923, 377.) From butter.

Mycobacterium cholesterolicum Tak. (Antonie van Leeuwenhoek, 8, 1942, 39) From garden soil.

Mycobacterum friburgensıs (Korn) Chester. (Bacillus friburgensis Korn, Cent. f. Bakt., I Abt., 25, 1890, 532; Mycobacterum lacticola y friburgensis Lehmann and Neumann, Bakt. Disg., 2 Aufl., 2, 1899, 411; Chester, Man. Determ. Bact., 1901, 359) From butter.

Mycobacterium pramins Chester. (Grasbacillus II, Mooller, Cent f. Bakt., I Abt., 25, 1899, 369; Mycobacterium lacticola α planum Lehmann and Neumann, Bakt. Diag., 2 Aufi., 2, 1899, 469; Chester, Man. Determ Bact., 1901, 339; Mycobacterium lacticola planum Hang, Cent. f. Bakt., 11 Abt., 71, 1927, 8.) From hay dust.

Mycobacterium hyalinum Sohngen. (Cent. f. Bakt., II Abt., 57, 1913, 599) From garden earth.

Mycobacterium luteum Sohngen (loc. cit.). From garden earth.

Mycobacterium muris Simmons. (Jour. Inf. Dis., 41, 1927, 13.) From the feces of gray mice.

Mycobacterium phlei perrugosum Haag (Cent. I. Bakt., II Abt., 71, 1927, 6)

From soils and manure.

Mycobacterium phlei planum Hasg (loc

cit.). From soils.

Mycobacterium ranicola I and II Haag

(loc. cit.). From frogs.

Mycobacterium rubrum Söhngen (loc. cst.). From garden earth.

Mycobacterium snegmatis (Trevisan)
Chester (Smegma bacillus, Alvarea
and Tavel, Arch. Phys. norm et path,
6, 1835, 303; Bacillus snegmatis Trevisaa,
I generi e le specie delle Batteriacea.
1889, 143; Bacterium snegmatis Migdis,
Syst d. Bakt. 2, 1900, 497; Chester,
Man. Determ. Bact., 1901, 357.) From
smegma Weber (Arb. Kaiserl. Gesundheitsamte, 19, 1902, 251) finds Mycobacterium snegmatis acid- but not al clobaldast in contrast to the mammaliae

tubercle bacilli which are both acid-and alcohol-fast. Later observers (Bynoe, Thesis, McGill University, Montreal, 1931) have not found this a valid distinction

Mycobacterium smegmatis var muris Galli-Valerio (Cent. f. Bakt, I Abt, Orig, 75, 1915, 49.) From the preputial glands of the black rat (Mus rattus)

Mycobacterium stercoris Bergey et al. (Mist Bacillus, Moeller, Berlin, therartl. Wochnschr, 1898, 100; Mycobacterium stercusis (sac) Bergey et al., Manual, 1st ed, 1923, 376; Bergey et al., Manual, 4th ed, 1934, 542) From manure.

Mycobacterium testudints Friedmann and Prorkowski. (See Haag, Cent f Bakt, II Abt., 71, 1927, 5; apparently the same as Mycobacterium testudo, loc cit, 10.) This is probably Mycobacterium friedmanni. From turtles

Appendix II: Krassilnikov (Mikrobiol, 7. 1938, 335; and Ray Fungi and

Related Organisms, Izd. Acad. Nauk. Moskow, 1938, 121-130) describes a genus Mycococcus distinct from Hansgurg's (Österr. Bot. Ztschr., 38, 1888, 266) family Mycococcuccae (which is related to the funcji and distinct from Mycococcus Bokor (Arch. I. Mikrobiol.,

1, 1930, 1). Mucococcus Krassilnikov includes species that produce coccus-like cells. genetically related to the species included in Mucobacterium; reproduction is by fission or budding in different directions. often forming short, irregular chains with side branches; in old cultures, the veretative cells change into resting cells, the latter germinating in a manner similar to the spores of actinomyectes. Seven species are listed, with incomplete descriptions. Mucococcus ruber, M. capsulatus, M. luteus, M. citreus and M. albus are described in Krassilnikov's original paper. One of these (Mycococcus luteus) is dropped in his later monograph while descriptions of two new species are added (Mucococcus tetragenus and M. mucosus).

# FAMILY II. ACTINOMYCETACEAE BUCHANAN,\*

(Jour. Bact., 3, 1918, 403.)

Mycelium is non-septate during the early stages of growth but later may become septate and break up into short segments, rod-shaped or spherical in shape, or the mycelium may remain non-septate and produce spores on aerial hyphae. The organisms in culture media are either colorless or produce various pigments. Some species are partially acid-fast This family is distinguished from the previous one by the formation of a true mycelium. As compared with the next family, it is characterized by the manner of spore formation.

## Key to the genera of family Actinomycetaceae.

- I Obligate aerobic. The colonies are hacteria-like in nature, smooth, rough or folded, of a soft to a dough-like consistency, sometimes compact and leathery in young stages. Most forms do not produce any aerial mycelium; a few produce a limited mycelium, the branches of which also break up into oidiospores or segmentation sporcs. Some species are partially acid-fast. Genus I. Nocardia, p. 892.
- II. Anacrobic or microserophilic, parasitic; non-acid-fast, non-proteolytic and non-dustatic.

Genus II. Actinomyces, p. 925.

#### Genus I. Nocardia Trevisan.

(Trevisan, I generi e le specie delle Batteriacce, 1889, 9; Actinomyces Gasperni, Cent. f. Bakt., 15, 1894, 684 and Atti dell' XI congresso med. internat. Roma, 6, 1895, 82; not Actinomyces Harz, Jahresber. d. Much. Thierarenischule for 1877-1895, 189, 1897

licropici.,

Limi, 9, resistration of the transit hum et comp. 2, 1924, 1; Asteroizes a unitoi in allechard, Boil e Atti d. R. Accad. Med., 61, 1935, 90; Proactinomyces Jensen, Proc. Lian. Soc. New So. Wales, 66, 1931, 345.) Named for Prof. E. Nocard who first described the type species.

Stender filaments or rods, frequently swollen and occasionally branched, forming a mycelium which after reaching a certain size assumes the appearance of facterium-like growths. Shorter rods and coccoid forms are found in older cultures. Conida not formed Stain readily, occasionally showing a slight degree of acid-fastness. Non-motile. No endospores. Aerobic. Gram-positive. The colonies are similar in gross appearance to those of the genus Mycobacterium. Paraffin, phenol and mo-cresol are frequently utilized as a source of energy.

m-cresol are frequently utilized as a source of energy.

In their early stages of growth on culture media (liquid or solid), the structure of nocardias is similar to that
hyphae branch abundantly,

where is that they form a typical meeters of the hyphae
hyphae branch abundantly,

where is to the soccess

vary between 0.5 and 1 mic.

The mycelium is not septate. However, the further development of nocardisa differs sharply from that of actinotayces: the filaments soon form transverse walls and the sharply from that of actinotayces: the filaments soon form transverse walls and the whole mycelium breaks up into regularly cylindrical short cells, then into coccide whole mycelium breaks up into regularly cylindrical short cells, then into coccide the control of the contro

<sup>\*</sup> Completely revised by Prof S A Waksman, New Jersey Experiment Station, New Brunswick, New Jersey and Prof A T Henrici, University of Minnesota, Minnesota, May, 1943.

cells On fresh culture media, the coccoid cells germinate into mycclia. The whole cycle in the development of nocardias continues for 2 to 7 days. Most frequently the coccoid cells are formed on the third to fifth day, but in certain species (e.g., Nocardia rubra) they can be found on the second day.

Numerous chlamydospores may be found in older cultures of nocardias. They are formed in the same way as the chlamydospores in true fungi: the plasma inside the filaments of the inycelum condenses into elongated portions. In older cultures of nocardias many coccoid cells are changed into resistant cells. The latter are larger than the vegetative occoid cells; the plasma of these cells is thicker than the plasma of vegetative cells; on fresh media they germinate like the spores of actinomyces; they form 2 to 3 germ tubes. Besides the cells mentioned, numerous involution forms can often be found in older cultures of nocardias, the cells are thin, regularly cylindrical or occoold, are often transformed into a series of spherical or clliptical annules and a club-like form (2 to 3 micros and more)

The multiplication of nocardias proceeds by fission and budding, occasionally they form special spores. Budding occurs often — The buds are formed on the lateral surface of the cells, when they have reached a certain size, they fall off and develop into rod-shaped cells or filaments — The spores are formed by the brtaking up of the cell plasm into separate portions usually forming 3 to 5 spores, every portion becomes rounded, overed with a membrane and is transformed into a spore; the membrane of the mother cell dissolves and disappears — The spores germinate in the same way as those of actinomyces — They form germ tubes which develop into a mycelum.

The colonies of nocardias have a paste-lake or mealy consistency and can easily be taken up with a platinum loop; they spread on glass and occasionally render the broth turbid. The surface colonies are smooth, folded or wrinkled. Typical nocardias never form an aerial mycelium, but there are cultures whose colonies are covered with a thin coating of short aerial hyphae which break up into cylindreal oldiospores.

Many species of nocardias form pigments; their colonies are of a blue, violet, red, yellow or green color, more often the cultures are colories. The color of the culture serves as a stable character

Krassilnikov (Ilay fungi and related organisms, Ital Acad Nauk, U S S R, Moscow, 1935) divides the genus into two groups 1 Well developed aerial mycelium, substrate mycelium seldom produces cross-salls, the threads break up into long, thread-like rods; branches of the aerial mycelium produce segmentation spores and olidospores, the latter are cylindrical with sharp ends; no spirals of fruiting branches. This group is the same as group B of Jensen (loc cit ). 2 Typical forms; mycelium develops only at early stages of growth, then breaks up into rod-shaped and occord bodies, smooth and rough colonies; dough-like consistency, never form an aerial mycelium, similar to bacterial colonies; aerial mycelium may form around colonies. This genus can also be divided, on the basis of acul-fastness, into two groups: Group 1. Partially acid-fast organisms, which are non-proteolytic, non-divistatic and utilize parafilm, usually yellow, pink, or orange-red in color. Group 2. Non-acid-fast organisms, which are dastatic, largely proteolytic and do not utilize parafilm; yellow, orange to black in color

The type species is Nocardia farcinica Trevisan.

#### Key to the species of genus Nocardia.

- I Partially acid fast\* organisms with strongly refractive cells, non-proteolytic and generally non-diastatic, constantly capable of utilizing paraffin.
- Acid-fastness is not marked in cultures, is apparent in infected tiesues, pronounced in sputum or other exudates.

A. Initial mycelium well developed, richly branching, dividing into rods and generally into cocci.

1. Vegetative mycelium soft, without macroscopically visible aerial mycelium.

a. Vegetative mycelium yellow, orange or red. b. Pathogenic.

c. Vegetative mycelium white, buff, or pale yellow

1. Nocardía farcinica. cc. Vegetative mycelium yellow to red.

2. Nocardía asteroides.

bb. Not pathogenic,

3. Nocardía polychromogenes.

as. Vegetative mycelium white to pink.

Gelatin not liquefied.

c. Growth on nutrient agar opaque, cream-colored;

coccoid forms in broth. 4. Nocardía opaca.

cc. Growth on nutrient agar watery, no coccoid forms in broth.

Nocardia erythropolis.

ccc. Growth on nutrient agar pink. d. White serial mycelium on milk.

6. Nocardia leishmanii.

dd. Pink pelliele on milk. 7. Nocardia caprae.

ddd. Yellow pellicle on milk 8. Nocardia pretoriana.

bb. Gelatin liquefied.

9. Nocardia pulmonalis. 2. Vegetative mycclium hard, yellow, with white aerial mycelium; hyphse

divide into chains of acid-last cocci. 10. Nocardia paraffinae.

B. Initial mycelium very short, rapidly dividing into rods and cocci

Slowly growing organisms; cells 0 5 to 0.7 micron in diameter.

11. Nocardia minima. 2 Rapidly growing organisms; cells 1 0 to 1.2 microns in diameter.

a, Growth pink.

b. Cystites (swollen cells) not formed.

e. No indigotin from indole. 12. Nocardia corallina.

ce. Indigotín from indole.

13. Nocardia globerula.

bb. Cystites formed 14. Nocardia salmonicolor.

as. Growth coral red. 15 Nocardia rubropertincia.

asa Growth dark red 16. Nocardia rubra.

seas. Growth white

b No aerial mycelium. 17. Nocardia coeliaca.

bb. Aerial mycclium.

18. Nocardia transvalensis.

- II. Non-acid-fast organisms with weakly refractive cells; no distinct formation of
  - A. Not protectivitie.
    - 1. Growth on sear pale cream.
      - 19 Nocardia mesenterica
    - Growth on agar yellow.
- 20 Nocardia flava.
- 3. Growth on agar green.
- 21 Nocardia vicidia
- 4. Growth on agar vellow-green
  - 22 Nocardia citrea.
- 5. Growth on agar pink to crimson.
- 23 Nocardia madurae.
- 6. Growth consistency soft, sparse serial mycelium.
- 7. Growth consistency medium, good serial mycelium.
- 25 Nocardia blackwillii.

  8. Good action on milk. Growth consistency firm, liberal, acrisl myce-
- lium.
  - 26. Nocardia cuniculi
- 9. Deep brown pigment on protein media.
- 27 Nocardia rangoonensis.
- 10. Light brown pigment on protein media.
- B. Proteclytic.
- B. Proteolytic
  - Growth on nutrient agar with rapid formation of unbranched diphtheroid-like rods; no typical cystites; broth turbid.
     Necardia actionmarsha.
  - 2. Growth on nutrient agar with extensive mycelia; simple unbranched
  - rods not formed; cystites present. Broth clear.

    30 Nocardia flarescens.
  - 3. Colonies orange-yellow to orange-red, which may change to black.
    - 31 Nocardia maculata.
  - 4. Light brown pigment on protein media
    32 Nocardia rhodnii.
  - 5. Green to greenish-brown pigment on protein media.
    - 33 Nocardia gardneri.
- 1. Nocardia farcinica Trevisan. (Bacille du farcin, Nocard Ann. Inst. Past. e, 1888, 293; Trevisan, i generi e le specie delle Batteriacce, Milan, 1889, 9; Streptotris farcinica Rossi Doria, Ann d Ist d'Igi Sper. Univ. di Roma, 1, 1891, 421; Actionmyces farcinicus Gasperiin, Ann Ist. d'Ignene, Roma, e, 1892, 222; Ouspora farcinica Sauvasçau and Radais, Ann Inst. Past., 6, 1892, 218; Actinomyces borsi farcinicus Gasperiin, Cent. f Bakt., 18, 1891, 681; Racillus Jerenicus Gasperini, Cent. f Bakt., 18, 1891, 681; Racillus Jerenicus Gasperinicus Gas

perini, shul; Cladolhriz farentica Mach, Traité de Bactérologie, 3rd ed., 1894, 1047; Streptothriz farenti boris Kitt, Baktenenkunde und pathologische Mikroskopie, Vienna, 3 Aufl, 1899, 511; Bacterum nocardi Migula, Syst d. Bakt, 2, 1900, 315, Streptothriz nocardi Foulerton, Jour. Compt Path, and Therap. 14, 1901, 51; Discompres farcinicus Gedeckt, Les champignons parasites de Phomme et des animaux domestiques, Brussels, 1902, 107; Ac. tinomyces nocardii Buchanan, Veterinary Bacteriology, Philadelphia, 1911, 378, Nocardia albula Chalmers and Christopherson, Ann Trop. Med and Parasit., 10. 1916, 271, according to Dodge, Medical Mycology, St. Louis, 1935, 746.) From M. L. farcinicus, of farcy.

Filaments 0 25 micron in thickness, branched. Markedly acid-fast.

Gelatin colonies: Small, circular, transparent, glistening.

Gelatin stab: No liquefaction.

Agar colonies: Yellowish-white, irregular, refractive, filamentous.

Agar slant: Grayish to yellowish-white growth, surface roughened.

Broth · Clear, with granular sediment, often with gray pellicle.

Litmus milk. Unchanged.

Potato: Abundant, dull, crumpled, whitish-yellow growth.

Nitrites not produced from nitrates. No soluble pigment formed.

Proteolytic action absent

Starch not hydrolyzed. Aerobic, facultative

Optimum temperature 37°C.

Source: From cases of bovine farcy. Habitat: Associated with a disease in cattle, resembling chronic tuberculosis. Transmissible to guinea pigs, cattle and sheep, but not to rabbits, dogs, horses or monkeys

(Eppinger) asteroides 2 Nocardia (Cladothrix asteroides Ep-Blanchard pinger, Bestr. z path Anat , 9, 1891, 287; Streptotrix (sic) eppingerii Rossi Doria, Ann. Inst d'Ig. sper d. Univ. Roma, 1, 1891, 423, Streptotrix (sic) asteroides Gasperini, Ann Inst d'Ig. sper. d. Univ. Roma, 2, 1892, 183; Oospora asteroides Sauvageau and Radais, Ann Inst Past., 6, 1892, 252; Actinomyces asteroides Gasperim, Cent. f. Bakt , 15, 1894, 684; Blanchard, in Bouchard, Traité Path. Gén , 2, 1895, 811, Discomyces asteroides Gedoelst, Champ. Paras Homme et Anım , 1902, 173, Actinomyces eppingeri Namyslowski, Cent f. Bakt., I Abt., Orig., 62, 1912, 566; Asteroides asteroides Puntoni and Leonardi, Boll. e Atti d R. Accad. Med. di Roma, 61, 1935, 92, Mycobacterium asteroides, quoted from Puntoni and Leonardi, idem; Proactiasteroides Baldacci, Soc nomuces Internat. di Microb., Boll. d Sez. Ital, 9. 1937, 141.) From Greek aster, star and cidos, shape

Probable synonyms: Streptotrix aurantiaca Rossi Doria, loc cit., 417 (Actinomyces aurantiacus Gasperini, loc. cu, 1892, 222; Oospora aurantiaca Lehmann and Neumann, Bakt. Diag , 1 Aufl , 2, 1896, 388; Cladothrix aurantiaca Mace, Traité Pratique de Bact . 4th ed., 1901, 1026; Nocardia aurantiaca Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268) and Streptothriz freeri Musgrave and Clegg, Philippine Jour. Sci., Med. Sciences, 2, 1907, 477 (Discomyces freeri Brumpt, Précis de Parasitol., Paris, 1st ed , 1910, 858, Nocardia freeri Pinay, Bull. Inst. Past, 11, 1913, 936; Cospora freeri Sartory, Champ. Paras. Homme et Anim., 1923, 785; Actinomyces freers Bergey et al, Manual, 1st ed., 1923, 346). According to Chalmers and Christopherson (loc. cit.) another synonym of this organism is Streptothrix hominis Sabrazès and Rivière, Le Semaine Médecine, 1895, no. 44.

Straight, fine mycelium, 0.2 micron in thickness, which breaks up into small, coccoid conidia. Acid-fast.

Gelatin stab . Yellowish surface growth No growth in stab. No liquefaction Synthetic agar : Thin, spreading, orange

growth. No aerial mycelium Starch agar: Restricted, scant, orange

Plain agar: Much folded, light yellow

growth, becoming deep yellow to yellowish rod . alliale.

No coagulation No peptomzano. Potato. Growth much wrinkled, whitish becoming yellow to almost brick-red. Nitrites produced from nitrates. No soluble pigment formed. Proteolytic action doubtful. Starch not hydrolyzed.

Transmissible to rabbits and guinea

Aerobic.

Ontimum temperature 37°C

Source: From a cerebral abscess in man Habitat: Also found in conditions resembling pulmonary tuberculosis

A number of strains of acid-fast actinomycetes isolated from human lessons have deviated in certain particulars from the description of Nocardia asteroides, but not sufficiently to warrant separation as species. The following varieties are described by Baldacei (Mycopathologia, 1, 1938, 68): Nocardia asteroides yas, crateriforms

Rocarda asterones var. caterijormas (Baldacci) comb. nov (Proactinomyce asteroides var crateriformas Baldacci, loc cit.) Less tendency to fragmentation of mycelium Complete lack of aerial mycelium Growing as discrete colonies, dask, or center-abaned

Nocardia asteroides var decolor (Baldacci) comb. nov. (Proactinomyces asteroides var. decolor Baldacci, loc cit) Greater tendency to produce white aerial mycelium; vegetative mycelium colorless.

Nocardia asteroides var gypsoodes (Baldacci) comb now (Actinomyces gypsoodes Henrici and Gardner, Jour. Inf Dis , 28, 1921, 248, Direcomyces gypsoodes Brumph, Précis de Pransatol, Paris, 3rd ed., 1922, 980, Oorpora gypsoides Sartory, Champ Paras Homme et Anim, 1923, 802, Proactinomyces asteroides var gypsoides Baldacci, loc cit) White actial my celium; darkening of nertione media

3 Nocardia polychromogenes (Vallée) comb nor. (Streptothriz polychromogenes Vallée, Ann Inst. Past., 17, 1903, 288; Streptothriz pluricromogena Caminiti, Cent f Bakt, I Abt, Orig, 44, 1907, 198; Actinomyces polychromogenes Lieske, Morphol. u. Biol. d. Strahlenpilze, Leipzig, 1921, 32; Proactinomyces polychromogenes Jensen, Proc. Linnean Soc. New So Wales, 66, 1931, 79 and 303, Oospora polychromogenes Sartory, quoted from Nannızzi, in Pollacei, Tratt. Micopat Umana, 4, 1934, 51; Actinomyces plurichromogenus Dodge, Medical Mycology, St. Louis, 1935, 737.) From Greek, producine many colors

Description from Jensen (for. ctt.). Long wavy filaments: 0.4 to 0.5 by 70 to 100 microns, extensively branched but without septa. Older cultures consist entirely of rods 4 to 10 microns, frequently in V, Y, or smaller forms. Still older cultures consist of shorter rods and coccold forms. Gram-positive, frequently showing bands and eranules

Gelatin stab. Thin yellowish growth along the stab with thin radiating filaments. Surface growth flat, wrinkled, red. No liquefaction

Nutrient agar. Scant, orange-red growth.

Glucose agar. After 3 to 4 days raised, flat, glistening, rose-colored growth After 1 to 3 weeks becoming folded and coral and

Glucose broth After 3 to 4 days turbid, after 2 to 3 weeks an orange flaky sediment. No surface growth.

Milk Growth starts as small orangecolored surface granules After 1 to 2 weeks a thick, soft, orange-colored sediment forms

Optimum temperature 22° to 25°C. Distinctive characters. Differs from Nocardia corallina in the formation of very long filaments and in filiform growth in relatin stabs.

Source. From the blood of a horse; from soil in France and Australia.

Habitat Soil.

4 Nocardia opaca (den Dooren de

4 Nocardia opaca (den Dooren de Jong) comb. nov. (Mycobacterium opacum den Dooren de Jong, Cent. f Bakt., II Abt., 71, 1927, 216; Mycobacterium crysiallophagum Gray and Thornton, Cent. Description from Erikson (Med. Res. Council Spec. Rept. Ser. 203, 1935, 26).

Initial cells only slightly enlarged; carly development of aerial hyphac, while substratum threads are still short; frequent slipping of branches; serial mycelium abundant on all media with tendency to form coherent spikes; mycelium not very polymorphous, but occasional thicker segments appear. Slightly acid-fast.

Geletin: Extensive dull growth with small raised patches of pink serial mycehum; later ribbon-like, depressed. No

liquefaction.

Glucose agar: Irregular bright pink growth tending to be heaped up; later abundant masses frosted over with thin white aerial mycelium.

Glycerol agar Abundant growth, small round pink colonies, partly covered with white acrial mycelium.

Potato agar Extensive thin growth, pink in raised patches, covered by white actial mycelium; later aerial mycelium also becomes pink

Starch agar Minute colorless colonies covered by white aerial mycelium

covered by white aerial mycelium

Blood agar. Minute round colorless
colonies aggregated in broad pink zones,
paler aerial mycelium No hemolysis.

Dorset's egg medium Few colorless colonies, some pink, white aeral mycelium; later, growth becoming dull pink, irregular, with scant white aeral mycelium.

Ca-agar Minute colorless colonies, white aerial mycelium; later a pinkish tinge

Serum agar Small round pink colonies frosted over with thin white serial mycelium

Inspissated serum No growth

Broth Superficial pellicle composed of pink colonies with white aerial mycelium; moderate floculent sediment

Glucose broth. Small sediment of fine flocculi; later pellicle composed of small pink colonies; superficial skin entire and salmon colored in 16 days Synthetic glycerol solution: Round pink disc-like colonies on surface and tenuous white wispy growth in suspension and sediment; after 20 days, surface colonies bearing white aerial mycelum extending 2 cm up tube.

Synthetic sucrose solution: Minute white colonies in suspension and sediment in 3 days; thin dust-like pelhele in 10 days; some surface colonies with white aerial mycelium in 17 days.

Milk: Red surface skin; solid coagulum Litmus milk: Red surface growth, no change in liquid; after 4 weeks, liquid decolorized, organic.

Potato plug: Abundant growth, small colonies, mostly confluent, entirely covered with pale pink serial mycelium; growth becomes membranous, considerably buckled; later superficial colonies with pink serial mycelium on liquid at base of tube, bottom growth of round withte colonies.

Starch not hydrolyzed. Source: From lesions in goats.

8. Nocardia pretoriana Pijper and Pullinger. (Pijper and Pullinger, Jour. Trop. Med. Hyg., 30, 1927, 183; Actinomyces pretorianus Nannizzi, in Polisco; Tratt. Micopat. Umana, 4, 134, 8, Named for Pretoria in South Afrea.

Description from Er.kson (Med. Res. Council Spec. Rept Ser. 203, 1935,

Alinute flat colonies are formed consisting of angularly branched flaments, and bearing a few short straight aerial hyphae; later the growth becomes spreading and extensive, the slipping of he-branches is well marked and the

Gelatin: A few cotoriess manu-

Glucose agar: Pale buff umbilicated and piled up colonies.

Glycerol agar: Piled up pink mass, very scant white aerial mycelium at margin Ca-agar: Yellowish wrinkled coherent growth with white aerial mycelium on anices and at margin.

Coon's agar. Colorless mostly submerged growth, scant white aerial myce-

Dorset's egg medium. A few round colorless colonies in 3 days, after 3 weeks, irregular raised pink mass, warted appearance, moderate degree of liquefac-

Serum agar. Raised, convoluted, slightly pinkish growth.

Insussated serum. No growth

Broth Moderate quantity of flakes and dust-like surface growth

Synthetic sucrose solution A few colorless flakes on the surface, lesser bottom growth

Milk Yellowish surface growth, solid coagulum in one month, later, partly digested, pale pink growth up the wall of the tube.

Litmus milk Colorless surface growth, liquid blue, becoming hydrolyzed and decolorized

Potato plug. Small raised pale pink colonies with white aerial mycelium; after 2 months, plug and liquid discolored, growth dull buff, dry and convoluted at base, round and zonate at top of slant, white aerial mycelium, surface and bottom growth on lound

Source: From a case of mycetoma of the chest wall in a South African native Habitat. Human infections so far as known

9. Nocardia pulmonalis (Burnett) comb nov. (Actinomyces pulmonalis Burnett, Ann. Rept N. Y. State Vet Coll, 1909-1910, 167.) From Latin pulmo, lung

Gram-positive mycelium breaking up readily into oval shaped conidin. Acidfast, especially in early stages of growth

Gelatin Small, whitish, spherical colonies, edges of colony becoming chalky white; limited liquefaction Agar: Moist, raised growth in the form

Glucose agar. Dull, whitish, convoluted growth.

Broth: Delicate, translucent film on surface, becoming corrugated with some whitish, spherical colonies in medium.

Milk: Colonies on the surface of the medium, milk is coagulated in a few days later digested.

Potato. Luvurant growth in the form of small, translucent, round colonies; of semall, colored lemon-yellow; later, growth becomes convoluted or folded with chalky white aeral mycelum, color of plug brownish.

Non-methecome for rightus and quince.

pigs

Aerobic.

Source From the lungs of a cow Habitat: Bovine infections so far as known.

10. Nocardia paraffinae (Jensen) comb nov. (Proactinomyces paraffinae Jensen, Proc Linn Soc. New So Wales, 56, 1931, 362) From M. L. paraffina, paraffina

In agar media, the organism initially forms an extensive mycelium of long. richly-branching hyphae, 0.4 to 0.5 mieron thick. After 5 to 6 days at room temperature, numerous end branches swell to about double thickness, become more refractive, exhibit fine incisions along their external contours, and divide into oval, spore-like elements, 0 8 to 1 0 by 1 2 to 1 5 microns This process of division starts at the tips of the swollen branches and proceeds hasinetally until most of the hyphae appear divided. Primary senta have not been seen in the hyphae. A similar process of division takes place in liquid media, where also the filaments often fall into fragments of variable length. The spore-like elements. but not the undivided filaments, are markedly acid-fast. The acrial mycehum consists of rather short, straight, not very much branched hypline, 0.4 to 0 6 micron thick, which never show any differentiation into spores.

Gelatin: No liquefaction.

Sucrose agar: Very scant growth. Thin colorless veil, sometimes with a trace of white aerial mycelium.

Glucose agar: Fair growth. Vegetative mycelium flat, growing into medium; pale other-yellow to orange, with raised outgrowths on the surface. Growth of a crumbly consistency. Scant, white, aerial mycelium.

Nutrient agar: Slow but good growth. Vegetative mycelium superficial, somewhat raised, ocher-yellow, hard, but with a loose, smeary surface. Aerial mycelium scant, small white tufts No pigment.

Potato. Fair growth. Vegetative mycelium granulated, first pale-yellow, later deep ochre-yellow to orange. Scant, white, aerial mycelium No pigment

Liquid media (milk, broth, synthetic solutions). Small, round granules of various yellow to orange colors, firm, but can be crushed into a homogeneous smear. In old broth cultures a thick, hard, orange to brownish surface pellicle is formed.

Sucrose not inverted

Starch not hydrolyzed

Cellulose is not decomposed

Nitrates are not reduced to nitrites.

Milk is not coagulated or digested. Final reaction in glucose NH<sub>4</sub>Cl solution, pH 4.6 to 4.4

All strains show a marked power of utilizing paraffin wax as a source of energy. Source: Isolated from soil.

Habitat Soil.

11. Nocardia minima (Jensen) comb.
nov (Proactinomyces minimus Jensen,
Proc Linnean Soc New So. Wales, 56,
1931, 365) From Latin minimus, very
small

Filaments and rods: 0.4 to 0.6 by 2 to 10 microns In older cultures mostly short rods, frequently V, Y, swollen forms, or cocci. Irregularly stained with ordinary dyes, generally show bars and bands. Generally a few cells from cultures are acid-fast, most are not acid-fast. Gram-positive.

Gelatin stab: Filiform, granulated, cream-colored growth. No liquefaction. Agar: Slow growth, raised, folded, with finely myeloid margins. At first colorless, after 6 to 8 weeks flesh pink or coral

pink.
Potato: Growth slow, after 6 to 8 weeks
abundant, spreading, much raised, finely
wrinkled, coral pink.

Paraffin is utilized.

Optimum temperature 22° to 25° C. Distinctive characters: Closely resembles Nocardia corollina but differs in the much slower growth and the smaller size of the cells.

Source: From soil in Australia. Habitat: Soil.

12. Nocardia corallina (Bergey et al.)
comb. nov. (Bacillus mycoides coralinus
Hefferan, Cent. f. Bakt., II Abt., II,
1904, 459; Serralia corallina Bergey et
al., Manual, let ed., 1923, 93; Steptelshiri
corallinus Reader, Jour. Path. and Baet,
29, 1926, 1; Mycobacterium agresie Gray
and Thornton, Cent. i. Bakt., II Abt.,
78, 1928, 84; Actinomyces agrestis Bergey
et al., Manual, 3rd ed., 1300, 472; proactinomyces agrestis Jensen, Proc. Lianean Soc. New So. Wales, 59, 1921, 315;
Procatinomyces corallinus Jensen, ibid.,
57, 1932, 364.) From Latin corollinus,
coral red.

Description from Gray and Thornton (loc. cit.), Jensen (loc. cit.) and Bynoc (Thesis, McGill University, Montreal, 1931).

Branching rods, generally curved, 1 to 1.5 by 3 to 10 microns. In older cultures generally shorter rods and cocci. Nonmotile. Not acid-fast. Gram-positive.

Gelatin colonies: Round, convex, smooth, pink, shining, edge filamentous Deep colonies: Burrs Goldtin stab: Nailhead; line of stab arborescent. No liquefaction.

Agar colonies: Round, convex, or umbonate, smooth, pink, shining or matter, border lighter, edge filamentous or with arborescent projections. Deep colonies: Burns, or lens-shaped, with arborescent projections. In their very early stages colonies consist of branching filamentous rods. As the colony grows, the cells in the interior break up into short rods and cocci which eventually form the mass of the colony. Cells on the outside remain filamentous, giving the colony a burrlike appearance, and often forming long arborresent trucesses.

Agar slant: Filiform, convex, smooth, pink, shining or matte; arborescent or with projections from undulate border.

Litmus milk: Alkaline. Reddish pel-

Glycerol potato: Filiform, raised, dry, wrinkled, yellowish-brown to coral red

Broth: Usually turbid. Pink scum
Dorset's egg medium: Filiform, raised,
dry. wrinkled. orange.

Loeffler's medium: Similar to growth on Dorset's egg medium, but pink

Nitrites produced from nitrates. Acid from glycerol and glucose with some strains. No acid or gas from suerose, maltose or lactose.

Phenol and m-cresol are utilized Some strains utilize naphthalene. (Gray and Thornton) Some strains utilize phenol or m-cresol (Jensen)

Optimum pH 68 to 80

Optimum pil 68 to 80 Optimum temperature 22° to 25°C.

Distinctive characters, Soil organism forming Mycobacterium-like colonies after 2 to 4 days on simple media. Pale pink chromogenesis Nailhead growth in gelating the back of the properties of t

Source · Seventy-four strains isolated from soils in Great Britain and Australia. Habitat · Soil

13 Nocardia globerula (Gray) comb.
nov (Mycobacterium globerulum Gray,

Proc. Roy. Soc. London, B, 102, 1928, 265; Proactinomyces globerulus Reed, in Manual, 5th ed., 1939, 838.) From Latin glubus, a sphere.

Description from Gray (loc. cit.) and from Bynoc (Thesis, McGill University,

Montreal, 1931).

Curved rods and filaments 1 by 2 to 9 microns, with many cocoold cells, especially in old cultures. Rods and filaments are frequently irregularly swollen. Not acid-fast. Capsules may be present. Gram-positive.

Gelatin: After 19 days surface colonies irregularly round, 1 to 2 mm in diameter, convex, light buff, smooth, shining; edge entire. Deep colonies: Round, with entire edge.

Gelatin stab: After 8 days nailhead, irregularly round, convex, pinkish-white, smooth, shiping: line of stab errore

Agar: After 4 days surface colonies irregularly round, 3 to 5 mm in diameter, convex, white, amooth, shining; edge undulate, erose. After 7 days, more convex and of a watery appearance Deep colonies: After 4 days, lens-shaped

Agar slant. After 3 days, filiform, flat, watery; edge irregular Nutrient and peptone broth: Turbid

with viscous suspension.

Litmus milk; Alkaline

Glycerol potato: After 21 hours, filiform, moist, smooth, pale pink.

Dorset's egg medium: After 2 weeks, spreading, raised, moist, orange-colored Loeffler's medium: Growth as on

Dorset's egg medium, but salmon-colored. Nitrites not produced from nitrates.

No acid from glucose, lactose, maltose, sucrose or glycerol.

Phenol is utilized Indole agar · Blue crystals of indicatin

formed.

Optimum temperature 25° to 23°C.
Optimum pli 6.8 to 7.6.

Distinctive characters: This organism resembles most closely Nocardia corallina. It is distinguished by producing a more natery type of surface growth, more nearly entire deep colonies and more particularly by the production of indigotin from indol.

Source: From soil in Great Britain. Habitat: Presumably soil.

14. Nocardia salmontcolor (den Dooren de Jong) comb. noc. (Mycobacterium salmontcolor den Dooren de Jong, Cent. f. Bakt, II Abt., 71, 1927, 216; Flavobacterium salmonicolor Bergey et al., Manual, 3rd ed., 1930, 157; Proactinomyces salmonicolor Jensen, Proc. Linnean Soc. New So. Wales, 67, 1932, 368.) From Latin salmo, salmon and color, color.

Closely related to Nocardia corallina. On glucose-asparagine-agar after 18 to 24 hrs., long branching rods are formed. 10 to 1.3 microns in thickness, with small refractive granules of aerial mycellum, sometimes stretching into quite long filaments; after 2 to 3 days small definite mycelia are present, and after 5 to 6 days these have largely divided into short rods and cocci; the colonies have the same burr-like appearance as those of Nocardia coralling. Many cells at the edge of the colonies show, after 3 to 4 days, club- or pear-shaped swellings, up to 25 to 30 microns in width; after 5 to 6 days, many of these snollen rells are seen to germinate with the formation of two more slender sprouts (Orskov. Investigations into the Morphology of the ray fung: Copenhagen, 1923, 82, gives an almost identical picture of Streptothrix rubra, it is questionable, indeed, whether these two organisms are not really identical )

Gelatin At 20° to 22°C, scant arborescent growth in stab, small wrinkled orange surface colony. No liquefaction.

Glucose asparagine agar. Good growth, restricted, rather flat, edges lobate, surface warty, glustening, first pale orange, later ochre-yellow; consistency crumbly After 5 to 6 weeks the growth is paler

with many small round raised yellow secondary colonies.

Glucose-nutrient agar: Excellent growth, spreading, flat, dense, edges lobate, surface folded, glistening, yellow,

líc

cream-colored, later red; broth clear at first, slightly turbid after 3 necks

Milk: Good growth; pellicle of small cream-colored granules after 2 days, later a thick orange sediment. Not coapulated, but appears slightly cleared after 5 weeks, the reaction becoming alkaline.

Potato. Good growth, raised, warty, crumbly, glistening, at first buff, changing to orange and finally to almost bloodred.

Indole not formed.

Nitrate, ammonium saits, asparagine and peptone are utilized almost equally well with glucose as source of carbon, although the growth is most rapid with peptone.

Sucrose not inverted, although readily utilized with sodium nitrate as a source of nitrogen.

of nitrogen.

Paraffin readily utilized as a source of carbon.

Phenol not utilized.

No acid from glucose or glycerol

Starch not hydrolyzed-

No growth in oxygen-free atmosphere Source: Isolated from soil by means of an ethylamine enriched medium, at 37°C.

Habitat: Probably soil.

15. Nocardia rubropertincta (Hefferan) comb. nov. (Butterbacillus, Grasberger, Munch. med. Wochascht., 49. 1899, 343; Bacillus rubropertincius Heferan, Cent. f. Bakt., II. Abt., II., 1903, 460; Serratia rubropertinctus Bergey et al., Manual, 1st ed., 1923, 96; Mycobacterium rubropertinctum Ford, Textb. of Bact., 1927, 255; Proaclinomyces Turbropertinctus Reed, in Manual, 5th ed.

1939, 835.) From Latin, colored very red.

Buttner (Arch. Hyg., 37, 1926, 17) regards Mycobocterium cos as probably identical with Mycobocterium rubrum Sohngen (Cent. f. Bakt., II Abt., 57, 1913, 599), Grassberger's organism (dec ut.), Hormann and Morgentot's organism (Hyg. Rundsch., 7, 1898, 229), and Weber's organism (Arb. a. d. k. Gesundhettsantte, Berlin, 19, 1930).

To this list Lehmann and Neumann (Bakt. Ding., 7 Aufi., 2, 1927, 764) also add the organism of Ascher (Zischr f Hyg., 32, 1899, 329) and the butter bacillus of Aujersky (Cent. f. Bakt, I Abt, Orig, 31, 1902, 132)

Jensen (Proc Linnean Soc. New So Walcs, 49, 1931, 32) regards the following organisms as probably identical Bacterium rubrum Miguh. (Syst. d. Bakt., 2, 1900, 483) a preliminary description of which is given by Schneider (Arb. bakt Inst. Karlsruhe, 1, Heft 2, 1894, 213); probably this is also the organism referred to by Hang (Cent. I. Bakt., II Akt, 71, 1927, 35) as Bacterium rubrum, and Mycobacterium rubrum Söhngen (loc. et f.)

Description taken from Grassberger (loc. cit.), Hesseran (loc. cit.) and Jensen (loc. cit.).

Small rods. 03 to 09 by 1.5 to 30 microns Cells in 18 to 21 hour agar culture in beautiful angular arrangement, after 2 to 3 days nearly cocoid, 06 by 08 meron. Tendency for branching on glycerolagarafter 2 to 3 days, but branching does not occur commonly though granules of aerial mycelium are sometimes seen (Jensen). Not acid-fast (Grassberger) Acid-fast (Hefferan). Variable (Jensen). Non-motile Grampositive

Gelatin colonies - Irregular with cremate margin and folded surface Coral red

Gelatin stab: Surface growth like the colonics. Growth in stab at first thin, then granular to arborescent with chromogenesis. No liquefaction Agar colonies: Small, granular, becoming pink to red depending on composition of agar.

Agar slant: Dry, lustreless (R) to glistening (S), pink to vermillion red. Broth. Faint uniform turbidity with salmon-pink pellicle (in scales) which is renewed on surface as it settles to form a

Latmus milk: Thick, fragile, dull coral red surface scales and sediment. Unchanged (Hefferan) to alkaline and somewhat viscid after 3 to 4 weeks (Jensen).

red sediment (Hefferan, Jensen).

Potato Slow but excellent intensive red growth becoming dull orange (Jensen).

Nitrites not produced from nitrates; nitrates, ammonia and asparagine are almost as good sources of nitrogen as peptone (Jensen).

Benzine, petroleum, paraffin oil and paraffin are utilized as sources of energy (Sohngen). No action on manganese dioxide (Sohngen, Cent. f Bakt., II Abt., 40, 1914, 551).

Optimum pH 6 8 to 7 2 Growth stops at pH 4 9.

Temperature relations Grows well between 20° and 37°C (Jensen)

Aerobic to facultative anaerobe.

Distinctive characters: Mycobocterium-like colonies with coral to vermillion red chromogenesis on asparagine agar, potato, gelatin and other media. Short rods, seldom forms filaments. Generally not acid fast

Source Six cultures isolated from butter (Grassberger) Several cultures isolated from soil in Holland (Söhngen) and Australia (Jensen) Two cultures as contaminants in tuberculin flasks (Hagan, Breed)

Habitat. Probably widely distributed in soil.

16 Nocardia rubra (Krassilnikov) comb nor (Pronctinomyces ruber Kras silnikov, Bull Acad Sci U.S. S. R., No 1, 1938, 139) From Latin ruber, red Nitrogen is utilized as sodium nitrate, ammonium phosphate and asparagine, although these are inferior to peptone as sources of nitrogen

Source: Fermented beets.

20. Nocardia flava (Krassilnikov) comb. nov (Proactinomyces flavus Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139.) From Latin flaves.

yellow.

Cells at first filamentous, 0.7 to 0.8 micron in diameter; after 2 to 3 days broken into long rods and then into ecce 0.7 micron in diameter. No apores, some strains form chlamydospores. Cell multiplication by fission, cross-wall formation, rarefy by budding. Cells

Gram-positive; not acid-fast. Gelatin: No liquefaction.

Synthetic agar colonies: Bright yellow

or gold color.

Meat peptone media: Dirty yellow pigmentation.

Agar colonies: Pigment bright yellow or gold color on synthetic medas, dirty yellow on meat peptone media. Pigment not soluble in medium. Surface of colony somewhat shiny or rough and folded, of a dough-like consistency.

Milk: No peptonization or coagulation. Sucrose weakly inverted.

Starch is hydrolyzed.

Does not grow on paraffin and wax but

makes weak growth on fat. Habitat: Soil, not common.

21. Nocardia viridis (Krassilnikov) comb. nov. (Proactivanyces viridis Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139). From Latin viridis, green.

Myceial cells often branching, 0 7 to 0.8 micron in diameter with cross-wall; after 5 to 7 days the cells break up into rods 5 to 15 microns long. Cocci not observed. Cells multiply by fassion, seldom by budding. Spores not formed. Cells Gram-positive, not acid-fast

Gelatin: No liquefaction.

Colonies colored dark green. Pigment not soluble in medium, in water or in organic solvents. Surface of colony somewhat shiny. On potato, rough, much folded, broken up into small colonies.

Milk: No peptonization or congulation Sucrose readily inverted.

Starch weakly hydrolyzed.

Grows well on fats and paratin and less on wax.

Habitat . Soil.

22. Nocardia citrea (Krassilnikov) comb. nov. (Proactinomyces citreus Krassilnikov, Bull. Acad. Sci. U. S. S. R., No. 1, 1938, 139.) From M. L. citreus, lemon yellow.

Mycelium in young cultures consists of very fine threads 0.3 to 0.5 micron in diameter. After several days the cells break up into short rods 0.5 by 1.5 to 5 microns and into cocci 0.3 to 0.5 micron in diameter. Multiplies by fission and bud formation; spores not formed. Cells not acid-dash.

Gelatin: Liquefaction.

Colonies: Yellow-green, usually rough and folded.

Milk: Coagulation and peptonization. Sucrose is inverted.

Starch is hydrolyzed.

Weak growth on fat. No growth on naraffin or way.

Habitat: Soil and water.

23. Nocerdia madurae (Vincent)
Blanchard. (Streplothrix mad true Vincent, Ann. Inst. Past., 8, 1891, 193;
Blanchard, Bouchard's Traité de Path
Gén., 2, 1896, 868; Oospora madurae
Lehmann and Neumann, Bakt. Diss,
I Audi, 2, 1896, 888; Actromyces madurae
Lachner-Sandoval, Ueber Strablenpille.
1898, 64; Cladothrix madurae Macé,
Traité Pratique de Bact., 4th ed., 1901,
1900; Discomyces madurae Gedeelst,
Champ. Paras. Homme et Animany.
Paris. 1902. 169.) Named for the discase

Madura foot, with which this organism

Tospora unitee Kanthack (Kanthack, Jour Path and Bact , 1, 1893, 140; Nocardia indica Chalmers and Christopherson, Ann. Trop Med. and Parasit., 10, 1916, 231; Discomgess indicus Neveu-Lemaire, Précis de Parasitol Hum, 5th ed. 1921, 42; Actinomyees indicus Brumpt, Précis de Parasitol , Paris, 4th ed., 1927, 1190) is regarded by some authors as identical with Nocardia madurae Blanchard II this is established, then the correct name of the organism is Nocardia indica (Kanthack) Chalmers and Chaltenferson

The species described under the name Actinomyces madurae in previous editions of Bergey's Manual is definitely not the true causative agent of the disease and is probably a contaminant carried as a cultive of this appears.

Morphology in tissues, growth in form of granules consisting of radiating actinomycosis. In cultures, initial branched mycellum fragmenting into deshaped and coccoid bodies. No aerual mycelium or spores. Not acid-fast.

Gelatin Growth scant, whitish, no liquefaction

Gelatin colonies Round, glistening, at first white, then buff to rose or crimson Pigment production is irregular and unpredictable. Occasionally red soluble pigment is produced Growth eventually wrinkled. No serial mycelum

Potato Wrinkled friable growth, buffcolored, sometimes red

Broth Growth as a floccular sediment Milk No change, or slight slow peptenuzation

Dinatatic (?) action

Not pathogenic for the usual laboratory animals, pathogenic for monkeys (Musgrave and Clegg, Philippine Jour Ser, Ser B, Med. Sci, 3, 1908, 470).

Habitat Cause of some cases of Madura foot.

24 Nocardia lutea Christopherson and Archibald. (Christopherson and Archibald, Iancet, 2, 1918, 817; Actinomyces luteus Brumpt, Précis de Parasitol., Paris, 4th ed., 1927, 1206) From Latin luteus, yellow.

Description from Erikson (Med. Res. Council Spec. Rept. Ser. 203, 1935, 30).

Initial elements swollen and segmented, giving rise to tregular spreading polymorphous colonies composed of cells of all shapes and sizes with markedly granular contents. Later more monomorphous, the filaments being arranged in angular apposition. Sometimes (e.g., on synthetic glycerol agar) the segments are so granular as to appear banded. On potato agar, small filamentous colonies are formed with irregular angular branching and bear a few isolated short straight serial hyphes.

Gelatin: Pale pink wrinkled growth on wall of tube and colorless punctiform and stellate colonies in medium; no liquefaction.

Agar. Abundant, coherent, moist, pink membranous growth with round discrete colonies at margin, after 3 weeks colorless fringed margin, round confluent portion.

Glucose agar. Scant reddish smeary growth

Glycerol agar: Yellowish-pink, wrinkled membrane

Potato agar Coherent pink moist growth, centrally embedded with small mund discrete colonies at margin.

Dorset's egg medium Poor growth, dull pink, spreading.

Serum agar Confluent granular pink membrane

Broth Pink flakes and surface growth. Inspissated serum Raised convoluted pink mass, becoming orange, much wrinkled, scalloped margin.

Synthetic sucrose solution: Ited granules and abundant minute colorless colonies at bottom; in 2 weeks a colorless dust-like surface pellicle.

Glucose broth: Abundant, pinkish

flaky surface growth, breaking up easily and sinking to bottom.

Litmus milk: Orange-red surface and bottom growth, liquid blue.

Potato plug Carrot-red, moist, thick, granular growth in bands, partly ruised and with discrete round colonies; sparse coloriess very thin aerial mycelium at top of slaat in 2 months.

Source: From actinomycosis of the lachrymal gland.

25. Nocardia blackwellii (Erikson) comb. nor. (Actinomyces blackwellii Erikson, Med. Res. Counc. Spec. Rept. Ser. 203, 1935, 37.)

Description from Erikson (loc. cit., p. 32).

Initial elements short, rod-like, growing out into longer forms sparsely branching, small radating colonies are produced with short straight aerial mycelium, frequently large round or ovoid cells are interposed in the irregularly segmented chains of cells, being sometimes isolated in company with 2 or 3 short filaments and sometimes terminal.

Gelatin. Few colorless minute colonies along line of inoculation; after 30 days abundant colorless colonies to 10 mm below surface, larger pink yellow surface colonies with white aerial mycelium; no lituuefaction.

Agar: Confluent wrinkled growth with small, round, pinkish, discrete colonies at margin.

Glucose agar Abundant, pale pink growth, small conical colonies, piled up, convoluted.

Glycerol agar: Extensive, granular, irregular, thin, pinkish growth; after 40 days, a few discrete colonies with depressed margins, center piled up, pink.

pressed margins, center piled up, pine.

Serum agar: Smooth, cream, umbilicated colonics, with submerged growth
extending into medium in scallops 5 to 8
mm deep, a pale pink mass in 2 weeks

Potato agar. Small, round, colorless colonies covered with white serial mycelium; after 2 weeks colonies dull pink, submerged margins, few serial spikes, moderate aerial mycelium at top of slant.

Broth: Flakes, later innumerable minute colonies, some adhering to wall just above liquid level.

Synthetic sucrose solution: Delicate, round, white colonies; later abundant minute colonies in suspension, thick cream pellicle on surface and pink grains in sediment.

Milk: Heavy convoluted bright yellow surface pellicle, no congulation.

Litmus milk: Yellow surface growth, milky sediment, liquid unchanged.

Carrot plug: Small, round, smooth, cream-colored elevated colonies in 10 days; sparse stiff colorless aerial spikes in 16 days; abundantly piled up, convoluted, ochroous growth in 25 days.

Source: From hock joint of loal.

20. Nocardia cunteuli Snijdera. (Snijdera, Genecak, Trijdsch. Med. Ind., 464, 1924, 47 and 75; Actinomyees cuniculi Crikson, Med. Res. Council Spec Rept. Ser. 203, 1935, 32; not Actinomyees cuniculi Casporini, Cent. I. Bakt. 16, 1834, 654; Actinomyees sumatrae Erikson, loc. cit., 32.) From Latin cuniculus, rabbit.

Description taken from Erikson (loc.

cit., p. 31).

Large swollen cells give rise to ramifying filaments or to small chains of short thick segments which branch out into more regular hyptace; sometimes the irequiar elements are beset with spiny processes before giving rise to typical long branching filaments; later the picture becomes more monomorphous and short straight nerial hyptac are borne, which presently exhibit irregular segmentation.

Gelatin: Few flakes. No liquefaction-Agar: Small, round, elevated, creamcolored colonies, umbilicated and radially wrtakled.

Glucose agar Minute, colorless colon-

ies; becoming dull pink, partly confluent and piled up, few stiff pink aerial spikes.

Glycerol agar: Small round elevated cream-colored colonies, margins depressed; becoming smooth, discrete, vellowish.

Dorset's egg medium. Scant pinkish smeary growth.

Serum agar. Small, raised, creamcolored colonics, becoming confluent and piled up

Inapissated serum, Thick, colorless, ribbed membrane; no liquefaction Broth . Small and larger cream-colored,

scale-like surface colonies, abundant, flocculent bottom growth.

Synthetic sucrose solution; Thin surface pellicle, small colorless flakes, minute particles at bottom, scant growth Milk . Heavy yellow growth attached to

walls; solid coagulum in I month Litmus milk, Yellow surface growth,

hould unchanged.

Potato plug. Coral-pink, dry, granular growth, covered to a considerable extent with white serial mycelium, inled up in center, discrete colonies at margin, pink surface pellicle on liquid and colorless colonies at base

Source: Infected rabbits

27 Nocardla rangoonensis (Erikson) comb nov. (Actinomyces rangoon Erskson, Med. Res Council Spec Rept Ser. 203, 1935, 37 )

Description from Erikson (loc. cit. p. 33)

Swollen round initial cells, giving rise to branching hyphae which segment and present slipping and angular arrangement; few short straight aerial hyphae, which later develop into a profusely branching long waving aerial mycelium. Non-acid fast.

Gelatin Abundant minute colonies in depths and larger cream-colored ones on surface with white acred myechum: brown pigment surrounding growth No liquefaction.

Agar colonies: Round, lobate, umbili-

cated, raised up, cream-colored to pale pink; later, medium discolored dark brown, colonies colorless.

Glucose agar: Convoluted, coherent. cream-colored growth, medium discolored After 23 days, wrinkled, biscuit-colored growth, colorless margin, border white aerual mycelium, medium dark brown.

Giveerol agar. Dull, mealy, pink, wrinkled growth, scant white aerial mycelium at top, medium slightly discolored,

Coon's agar: Minute colorless colonies in streaks.

Potato agar: Small, round, lemoncolored colonies, partly confluent, with white serial mycelium, later medium discolored light brown, submerged growth

greenish. Dorset's egg medium : Extensive colorless growth, pale pink acrial mycchum in center, later covered with a powdery

pinkish-white acrial mycelium. Serum agar colonies Irregular, small, elevated, cream-colored, frequently um-

belieated. Inspissated serum Poor growth, small

piled up pink mass. Broth Abundant colorless growth. flocculent mass at bottom and pellicle

at surface, medium slightly discolored. Synthetic sucrose solution Small white colonics with pinkish tinge on surface. lesser bottom growth.

Milk Congulation, yellow surface ring, becoming partly pentonized, liquid discolored dark brown, brownish growth up side of tube.

Litmus milk Colorless growth, liquid partly decolorized; congulation; later nartly digested.

Carrot plug Small round colorless colonies, velvety white aerial mycelium: in 2 months, piled up pink granular mass with warted prominences, marrinal zone white aerial mycelium and thin all over central actial paycelium.

Source: Human pulmonary case of streptothricosis.

Habitat: Human infections so far as

28. Nocardia caviae Snijders. (Snidjers, Geneesk. Tijdschr. Ned. Ind., 04, 1923, 47 and 75; Actinomyces caviae Erikson, Med. Res. Countil Spec. Rept. Ser. 203, 1935, 37.) From the generic name of the guinea pig.

Description from Erikson (loc. cit., p 32).

Initial segmentation, producing elements of approximately even thickness arranged in angular apposition, and later long profusely ramilying threads with strongly refractile protoplasm. Aerial mycelium straight and branching, the aerial hyphae with occasional colled tips divided into cylindrical conidis.

Gelatin: A few colorless flakes. No liquefaction.

Glucose agar: Piled up, convoluted, cream-colored to pale pink growth, white acrial mycelium.

Glycerol agar: Scanty growth.

Coon's agar: Colorless scant growth, partly submerged, white serial mycelium. Potato agar: Colorless spreading growth

with dense white acrial mycelium.

Dorset's egg medium: Heavily corrugated pale pink growth with submerged margin, dense white acrial mycelium in center; after 3 weeks, colorless transpired drops.

Serum agar: Pale pink wrinkled growth, partly submerged; after 4 weeks, piled up with scant white aerial mycelium, medium discolored reddish-brown. Inspissated serum: Pale pink raised

growth, coiled, white aerial mycelium. Broth: Cream-colored wrinkled surface

pellicle extending up wall and breaking easily, moderate bottom growth, flaky, medium discolored Synthetic sucrose solution: Round

white colonies in suspension and attached to one side of tube, pink surface colonies with white aerial mycelium.

Milk: Colorless surface growth, white aerial mycelium; coagulation Litmus milk: Liquid blue, surface growth; after 1 month, white aerial mycelium, colorless sediment, liquid still blue,

Potato plug: Small colorless colonies, white powdery aerial mycelum; later abundant raised pale pink confluent growth, discolored plug; after 2 months, raised buckled pink colonies with white aerial mycelium floating on liquid at base. Source: Infected guines pigs, Sumats.

29. Nocardia actinomorpha (Gray and Thornton) comb. nor. (Mycobacterum actinomorphum Gray and Thornton, Cent. f. Bakt., II Abt., 73, 1923, 88; Attinomyces actinomorphus Bergey et al, Manual, 3rd ed., 1930, 471; Proceina-

shape, form.

Description from Gray and Thornton (loc. cit.), Jensen (loc. cit.), and Bynoe (Thesis, McGill University, Montreal, 1931).

Long branching filaments and rods: 05 to 0.8 by up to 10 microns. In older cultures rods 2 to 3 microns long generally predominate. On some media extentively branching byphae occur. Readily stained. Not acid-fast. Gram-positive

Gelatin colonies: After 12 days, round, saucer-like, white, raised rim, edges burred. Liquefaction. Deep colonies: Burrs.

Gelstin stab: After 8 to 14 days, seccate liquefaction, 5 to 8 mm.

Agar colonies: After 11 days, round, I mm in diameter, convex, white, gramlist or resinous; long arborescent processes from the edge. Deep colonies: Arborescent burrs; processes about equal to diameter of colony.

Agar slaut: Filiform, mised to convex, white, rugose, dull; edge undulate, with strong tufted projections below surface.

Broth Turbid, or clear with white scum

Dorset's egg medium: After 2 weeks, raised, dry, smooth, salmon-buff growth,

Loefler's medium: After 2 days, smooth, moist, warty, salmon-colored growth.

Litmus milk: Alkaline after 5 to 7 days. Glycerol potato: After 2 days, dry, wrinkled, pink to orange growth.

Nitrites are produced from nitrates.
No acid from glucose, lactose, sucrose
or glycerol.

Phenol and naphthalene are utilized Optimum temperature 25° to 30°C.

Optimum pH 7 8 to 8 5.
Distinctive characters: Differs from
Nocardia coeliaca in saccate liquefaction

of gelatin. Long rods and filaments. Source: A few strains have been isolated from soil in Great Britain and Australia

Habitat : Presumably soil.

30. Nocardia flavescens (Jensen) comb nov. (Proactinomyces flatescens Jensen, Proc. Linnean Soc. New So Wales, 56, 1931, 361.) From Latin flatescens, becoming golden yellow.

On media where a firm growth is produced, the vegetative mycelium appears as long, branched, non-sentate hyphae, 0 4 to 0 6 micron thick. In other media. as on nutrient agar and potato, senta are formed and the mycelium appears in preparations as fragments of very variable size, partly resembling highly branched mycobacteria, In goveral cases-for instance, on nutrient agar at 25° to 30°C, in 5 to 6 weeks old cultures in glucose broth, and in glucose NH, Cl solution-short elements assume avollen fusiform to lemon-shaped forms. The aerial mycelium consists of fairly long hyphae of the same thickness as the vegetative hyphre, not very much branched, without spirals, often clinging together in wisps. A differentiation into spores is never visible by direct microscopic examination. Neither is this the case in stained preparations; here the aerial hyphae break up into fragments of quite variable length, from 1.2 to 1.5 up to 10 to 12 microns, showing an irregular, granulated staining

Gelatin: Slow liquefaction.

Sucrose sgar: Good growth. Vegetative mycelium superficially spreading, much raised and wrinkled, cracking, white to cream-colored, of a dry, but loose and crumbly, consistency. Aerial mycelium scant, thin, white. Faint yellow soluble nigment after 2 to 3 weeks

Glucose agar: Good growth Vegetative mycelium superficial, wrinkled, honey-yellow, of a hard and cartilaginous consistency Aerial mycelium thin, smooth, white. Yellow soluble nigment.

Nutrient agar: Good growth. Vegetative my celium raised and much wrinkled, first dirty ercam-colored, later dark yellon ish-gray, of a soft, moist, curd-like consistency. No aerial mycelium. No pigment.

Potato: Good to excellent growth. Vegetative mycelium much raised and wrinkled, first cream-colored, later yellonish-brown, soft and smeary. No serial mycelium, no pigment.

Glucose broth Rather scant growth. Granulated, yellowish sediment; no surface growth. Broth clear No pigment. No scidity.

Sucrose is inverted.

Starch is hydrolyzed.

Cellulose is not decomposed.

Nitrates are reduced slightly or not at

all with various sources of energy.

Milk: Congulated and slowly redis-

Milk: Congulated and slowly redissolved with acid reaction.

Final reaction in glucose-NH<sub>4</sub>Cl solution, pH 3 9 to 3.6.

No growth under amerobic conditions. Habitat. Soil.

31. Nocardia maculata (Millard and Burr) comb. nor. (Actinomyces maculatus Millard and Burr, Ann. Appl. Bul-13, 1926, 580; Proactinomyces maculatus Umbreit, Jour. Bact., 53, 1939, 81.) From Latin maculatus, spotted.

Description taken from Umbreit.

Filamentous organisms possessing a tough shiny colony which is cartilaginous, mrely producing an aerial mycelium, though in certain strains, it may occur frequently. Retains the mycelium form for long periods. Not said-fast.

Gelatin : Liquefaction.

In the young colony an orange-yellow to orange-red intercellular pigment is produced on all media, which may or may not change to black as the culture ages.

Milk: No digestion.
Starch is hydrolyzed.
Does not utilize parallin.
Habitat: Sail

 Nocardia rhodnii (Erikson) comb. nov. (Actinomyces rhodnii Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 37.) Named for the insect genus, Rhodnius.

Description from Erikson (loc. cit., p 29).

In early stages, the minute colonies are composed of hyphal segments arranged in angular apposition; the aerial mycelium being short and straight. Later the growth becomes extensive and spreading, made up partly of long, genuinely branching filaments and partly of abort segments exhibiting slipping branching, each giving rise to aerial hyphae. After 2 weeks the angular branching is very marked, delicate spreading herring-bone patterns being formed.

Gelatin · Rapid liquefaction; pale pink colonies in superficial pellicle and sediment.

Coon's agar. Colorless pinpoint colonies.

Czapek's agar Minute, colorless, round colonics.

Glucose agar · Abundant, coral pink, convoluted, piled up growth

Glycerol agar Extensive growth, dull pink colonies round and umbilicated, becoming piled up and deeper coral, later partly submerged Dorset's egg medium: Salmon-pink, granular membrane; later piled up.

Serum agar: Extensive, reddish, confluent mass, granular, tending to be piled up; the medium around the growth shows reddish coloration in 2 weeks.

Inspissated serum: Smooth, round, pale pink colonies, centrally depressed and irregularly coiled larger mass; no liquefaction.

Broth: Salmon-pink flakes in sediment and colonies on surface; after 2 weeks abundant growth, discoloration of medium.

Glucose broth: Thin, pink, superficial pellicle, easily breaking up, and small flakes in sediment; after 2 weeks abundant growth extending up tube.

Synthetic sucrose solution: Colorless to pink colonies in superficial pellicle, and minute round white colonies coherent in loosely branching mass in sediment.

Milk: Bright orange growth; medium unchanged. Potato agar. Abundant, pink growth,

piled up, scant stiff white aerial mycelium at top of slant. Source: From reduvid bug, Rhodnius

prolizus.

33. Nocardia gardneri (Waksman) comb. nov. (Actinomycete, Gardner and Chain, Brit. Jour. Exp. Path., 23, 192, 123; Proactinomyces gardneri Waksman, in Waksman, Horning, Welsch and Woodruff, Soil Sci., 54, 1942, 289) Named for Prof. Gardner who first isolated this orcanism.

Gram-positive, branching mycelium.

Gelatin: Cream-colored surface ring Rapid liquefaction. Green to greenishbrown soluble pigment gradually diffuses through the liquefied portion.

Nutrient agar Cream-colored, elevated, lichenoid growth, soft, not leathery; no aerial mycelium; very faint brownish pigment.

Glucose agar: Brownish, lichenoid

growth, with wide, cream-colored edge; white to grayish aerial mycelium gradually covering surface. Reverse of growth vellowish: no soluble nigment.

Glucose-asparagine agar - Aerial myce-

Tryptone broth Growth occurs as small pellets at the base of the flask; later, a thin surface pellicle appears, which consists of a branching mycelum Black higment slowly produced

Litmus milk : Unchanged.

Potato Barnacle-like, brownish, spreading growth, no aerial mycelium Medium brownish araund growth.

Indole not formed.

No acid from glucose, lactose, maltose, mannitol, sucrose and dulcitol.

Good growth at 25°C. Slow growth at

Distinctive character. Produces an antibiotic substance (proactinomycin) upon synthetic and organic media which is primarily active against various Grammontive hacteria.

Source: Isolated as an air contaminant at Oxford, England.

\*Appendix I: The following species probably belong to this genus Many are incompletely described Some of the species listed here may belong in the genus Streptomyces

Actinomyces albus acidus Neukirch (Neukirch, Inaug Dies, Strawsburg, 1902, 50, Actinomyces albus var acidus Nannizzi, in Pollacci, Tratt Micopat Umana, 4, 1931, 9.) From a case of keratitis.

Actinomyces avadi Dodge (Streptothrix madurae Koch and Stutzger, Ztschr f Hjg., 69, 1911, 17; not Streptothrix madurae Vincent, Ann Inst. Past. 8, 1891, 129; Dodge, Medical Mycology. St. Louis, 1935, 729.) From a Madura foot in Egypt, case of Dr. Avad.

Actinomyces bolognesii-chiurcoi (Vuilleniin) Dedge (Malbrachea bolognesiichiurcoi Vuillenmi, in Bolognesi and Chiurco, Archivi di Biol. 1, 1925; Dodge, Medical Mycology, St. Louis, 1935, 766) From ulers in the thorax.

Actinomyces cameli (Mason) Sartory and Bailly (Streptothriz cameli Mason, Jour Trop, Med and Therap, \$2, 1919, 34, Ocspora cameli Sartory, Champ Paras Homme et Anum, 1923, 822, Sartory and Bailly, Mycoscs Pulmonaires, 1923, 233) From pseudotuberculosis lessons in a camel

Actinomuces canis (Rabe) Gisperini Discounces pleuritieus Vachetta Studi e ricordi clin Milano, 1882, Pleus romuces canas familiaris Rivolta, Giornali d Anat Fisiol, e Patol . 16, 1884, 4. Cladothrix canis Rabe, Berlin tierarzti. Wochnschr , 1888, 65, Gasperini, Ann Ist. d'Ie sper Univ Roma, 2, 1892, 222. Streptothrix canis and Actinomices pleuriticus canis familiaris, quoted from Gasperini, Cent f Bakt, 15, 1894. 684. Leptothriz pleuriticus Piana and Galli-Vallerio, 1896, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 37, Nocardia canis Chalmers and Christopherson, Ann Trop Med and Parasit . 10, 1916, 255. Oospora canis Sartory, Champ Paras, Homme et Anim 1923, 821 ) Rabe isolated this organism in two cases of phicemon and a case of peritoritis in does.

Actinomyces citroremeus Nannizii (Mycobacterum diphtheriae arium Trincas, 1907, quoted from Nannizii, in Poliacci, Tratt Micopat Umana, 4, 1931, 50, Nannizii, idem) Froma disease in birds

Actinomyces dassourilles Brocq-Rousseu, Thèse Sci

<sup>\*</sup>The appendix was originally prepared by Prof. S. A. Waksman and Prof. A. T. Henrier, May, 1943; it has been developed further by Mrs. Eleanore Heist Clise, Geneva, New York, August, 1945.

Nat. Paris, 1907; Nocardia dassonvillei Liégard and Landrieu, Ann. d'Occulistique, 46, 1911, 418; Discompace dassonvillei Brumpt, Précis de Parasitologie, Paris, 2nd ed., 1913, 976) Reported from a care cervical abseces (Brumpt), from a case of conjunctivitis (Liégard and Landrieu), and from grain (Pinoy, Bull. Inst. Past, 11, 1913, 292)

Actinomyces dermatonomus Over. (Bull. Austral. Jour. Exp. Biol. Med. Sci., 6, 1929, 301, quoted from Dodge, Medical Mycology, St. Louis, 1935, 719; Over, 1930, quoted from Nannizri, in Pollacci, Tratt. Micopat. Umana, 4, 1931, 51.) From lesions on sheep in Australia.

Actinomyces donnae Dodge. (Streptothrix sp. Donna, Ann. Ig. Sperim., 14, 1904, 449; Dodge, Medical Mycology, St. Louis, 1935, 745.) From sputum in a pulmonary infection.

Actinomyces dori (Beutmann and Gougerot) Brumpt. (Sporottrichum, Dor, Presse Méd., 14, 1906, 234; Sporotrichum dori Beutmann and Gougerot, Ann. Derm Syphiligr. IV, 7, 1906, 996; Discomyces dori Heutmann and Gougerot, Les Nouvelles Myeoses, 1909, 59; Rhinocladium dori Neveu-Lemaire, Précis Parasitol., 1921, 54; Gospora dori Bartory, Champ. Paras. Homme et Anim., 1925, 770; Brumpt, Précis de Parasitol., 4th ed., 1927, 1206; Necardat dori Vuillemin, Encyclopédie Myeologique, Paris, 2, 1931, 281.) Found in suboutaneous absesses resembling sporotrichosis.

Actinomyces hominis Berestneff, (Berestneff, Inaug. Diss., Moskow, 1897; not Actinomyces hominis Wakaman, Soil Science, 8, 1919, 120; Nocardia hominis Chalmers and Christopherson, Ann. Trop Med and Parasit., 10, 1916; Discomyces hominis Brunpt, Précis de Parasitol, Paris, 3rd ed., 1922, 984.) From a case of pseudoactinomycosis.

Actnomyces japonicus Caminti. (Streptothrix sp. Aoyama and Miramoto, Mitteil Med Fak K Jap Umv Tokio, 4, 1901, 231; abst. in Cent. f Bakt, I Abt, Orig., £9, 1901, 202; Camiali, Cent. I. Bakt., I Abt., Orig., 44, 1907, 1985; Streptolairiz zaponica Petruschly, in Kolle and Wasserman, Handb. d path. Mikroorg, 2 Aufl., 5, 1913, 205; Disconvece signonicus Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 581). From a case of netinomycosis of the lunes.

Actinomyces Leratolytica Acton and McGuirc. (Indian Med Gaz, 65, 1930, 61 and 68, 1931, C5; Proactinomyces Leratolyticus, author unknown) Produces cracked lucels among the ryots of India.

Actinomyces lepromatis de Souz-Araujo. (Compt. rend. Soc Biol., 10, 1929, 937.) From a leproma, Brazh. Actinomyces levyi Dodge. (Actinomyces 2p. Levy; Oospora 2p. Sartory, Champ. Paras. Homme et Anim., 1923, 827; Dodge, Medical Mycology, 5t Louis.

1935, 730.) From pus.
Actinomyces micetomae Greco.
(Streptolin:s micetomae argentines 6,
Greco, in Durante, Segunda Observación
de Pié de Madura o Alicetoma en la República Argentina, Thesis, Buenos Ares,
1911; Greco, Origina des Tumeurs, 1916,
759; Oaspora micetomae Sartory, Champ.
Paras. Homme et Anim., 1923, 783 |
From a case of mycetoma préis.

Actinomyces reinamus (LeCaive and Malberbe) Dodge (Oaspora forme de Microsporum (At. soutin' var. equanum). Bodin, Arch. de. 'arasitol. 2, 1899, 606; Trichophyton mainum LeCaive and Malberbe, Arch. de Parasitol.; Microsporum minimum. Castellani and Chalmers, May Trop. Med., 3rd el., 1919, 993; Dodge, Medical Mycology, 8t Louis, 1935, '28.) From ringworm of horse and de:

Actinompe : mucosus Basu (Indian Med Gar. 78, 1943, 577.) From browchial actinomycoris.

Actinom es neddeni Namyslowski. (Streptott 12 sp. zur Nedden, Klio Monstski. f. Augenheilk., 45, 1907, 152; Nan yslowski, Cent. f. Bakt., I Abt., Orig., 62, 1912, 561.) From a case of keratitis

Actinomyces nodosus (Beveridge)
Hagan. (Fusiformis nodosus Beveridge,
Austral. Council Sci. and Indus. Res.
Bul 140, 1941, 56 pp; Hagan, The Infectious Diseases of Domestre Aumals.
Ithaca, New York, 1913, 312.) Considered the primary cause of foot-rot of
sheep. Also see Spirochacta wenorths.

Actinomyces phenotoltrans Werkman. (in Gammel, Arch. Derm. Syphilol., 29, 1931, 285). From granuloma in man. Actinomyces punionii López Ortega (López Ortega, Annala d'Ignene, Rome, 44, 1931, 507; Asteroides punionii Puntoni and Leonvafi, Boll. e Atti di R. Accad. Med di Roma, 67, 1935, 91.) From a pulmonary abscess

Actinomyces purpureus Cavara. (Orloff, Vestnik Ofth., 29, 1912, 653, Cavara, Micosi Occ., 1928, 99, not Actinomyces purpureus Killian and Fehér, Ann. Inst. Past., 65, 1935, 620) From a case of keratilis in Russia.

Actinomyces ribeyro Dodge (Hongo artrosporado Ribeyro, Ann. Fac. Med. Luma, 3, 1919, 1; Dodge, Medical Mycology, St Louis, 1935, 735) From a generalized infection on the arms, legs and chest of a patient in Peru.

Actinomyces rodellae Dodge. (Streplothriz sp Rodella, Cent. f Bakt., I Abt., Orig, 84, 1929, 450, Dodge, Medical Mycology, St Louis, 1935, 731) From abscesses of the tooth and inw

Actinomyces ruber (Kruse) Sanfelice (Un Clatchriz cromogeno, Ruiz Casabó, Cronica medico-quirurgica de la Habana, 29, No. 13, 1891, 309, see Cent. f. Bakt, 1 Abt. 17, 1895, 466; Streplathir ruber Kruse, in Flügge, Die Mikroorganismen, 3 Aufl. et. 1896, 463, Cladafriz ruber Macé, Traité Pratique de Bact., 4th ed. 1991, 1997, not Actinomyces ruber Kraunky, Cent. f. Bakt., II Abt. 4f, 1911, 622; Sanfelice, Cent. f. Bakt., II Abt. 4f, 1911, 622; Sanfelice, Cent. f. Bakt., II Abt. off; 37, 1931, 325; Nocardia rubar Chalmers and Christopherson, Ann. Trop Med. and Parasit., fo, 1916, 263.

Discomyces ruber Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 931.) From sputum Some authors consider the following synonymous with this organism: Streptothriz mineacea (Actinomyces mineaceus Lachner-Sandoval, Unbers Strahlennilze. 1939. 66).

Actinomuces rubidaureus Lachner-Sandoval. (Cladothruz mordoré, Thirv. Arch. Physiol. Norm, et Path., 9, 1897. 283: Lachner-Sandoval, Heber Strahlennilge, Inaug Diss , Strassburg, 1898. 66. Actinomuces mordaré. Thiry. Thèse. Nancy, 1900, 82. Nocardia mordoré. Chalmers and Christopherson, Ann. Tron Med. and Parasit., 10, 1916, 265; Nocardia thirves de Mello and Pais. Arg. Hig. Pat. Exot . 6, 1918, 193; Discomuces thirm Brumnt, Précis de Para sitol . Paris. 3rd ed . 1922. 981: Oospora mordoré. Sartory. Champ. Homme et Anim . 1923. 824: Actinomyces thirm Sartory and Bailly, Mycoses Pulmonaires, 1923, 252 ) From a case showing anginous exudate with edema

Actinomyces salvati Langeron. (Langeron, Bull. Soe Path. Evot., 15, 1922, 526; Fontoynont and Salvat, 1914., 596.) From generalized nodular lesions in the Madazascar rat.

ladagascar rat.

Actinomyces sortorys Dodge. (Octoper pulmonalis var. acido-resistant, Sartory, Arch. Med. Pharm Milit., 70, 1916, 603; Dodge, Medical Mycology, St. Louis, 1935, 756 ) From a putient showing symptoms of pulmonary tuberculosis

Actinomyces septicus Mac Neal and Blevins. (Jour. Bact , 49, 1945, 605) From human endocarditis

Actinomyces serratus Dodge. (Actinomyces alteroide var. serratus Sartory,
Meyer and Meyer, Ann. Inst. Past., 44,
1930, 295; also see Compt. rend. Acad.
Sci. Paris, 183, 1929, 745; Dodge, Medical
Mycology, St. Louis, 1935, 745) From
a case of actinomycesis of bones with
yellow grains.

Actinomyces sommeri Greco. (Streptothriz madurae Greco, Primer Caso de Pié de Madura o Micetoma en la República Argentina, Thesis, Buenos Aires, 1901; Streptothriz micetomas argentinae a, Greco, in Durante, Segunda Observación de Pié de Madura o Micetoma en la República Argentina, Thesis, Buenos Aires, 1911; Greco, Origino des Tumeurs, 1916, 726; Nocardía micetomae-argentinae Durant, 1911, quoted from Brumpt, Précis de Paresitol., Paris, 3rd ed., 1922, 985; Oospora sommeri Sartory, Champ. Paras. Houtme et Anim., 1923, 783.) From a case of mycetoma pedis in Argentina.

Actinomyces tossicus Dodgo. (Actinomyces albus var. tossica Rossi, Ann. Ig. Sperim. 9, 1905, 693; Oospora alba var. toxique, Sartory, Champ. Paras Homme et Anım, 1923, 829; Dodge, Medical Mycology, St. Louis, 1935, 719) From tumors in the abdominal cavities of domestic four

Actinomyces urethridis Brumpt. (Précis de Parasitol., Paris, 4th ed., 1927, 1203.) Isolated by Roček in 1920 from cases of prostatitis

Actinomyces variabilis Cohn (Cent. f. Bakt., I Abt., Orig., 70, 1913, 301.) From pus in the bladder in a case of cystitis and from the prostate.

Asteroides pseudocarneus Puntoni and Leonardi. (Boll e Atti d R. Accad Med. di Roma, 61, 1935, 93.)

Bacillus berestnews Lepeschkin. (Cent. f. Bakt., II Abt., 12, 1904, 641 and 13, 1904, 13) From sputum of a pneumonia patient.

Bacillus (Micrococcus?) haraniensis Sternberg. (Sternberg, Manual of Bact, 1893, 718; Bacterium haraniensis Chester, Ann Rept Del Col Agr Exp Sta., 9, 1897, 116; Serratia haraniensis Bergey et al , Manual, 1st ed , 1923, 95) From human intestinal canal

Cladothriz matruchots Mendel. (Mendel, Compt rend. Soc. Biol., 88, 1919, 583; Nocardia matruchoti Pettit, 1921, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51; Oospora matruchots, quoted from Nan-

nizzi, idem; Actinomyces matruchoti Nannizzi, idem) From the roots of a decaying tooth with tumefaction. Spenes dubia.

Cohnistrepothrix misri Carpano (Riv. di Parassitologia, n 2, p. 107; quoted from Boll. d. Sez. Ital. d. Sec. Ital. d. Microbiol , 10, 1938, 62) From human dermatosis in Egypt.

Discomyces berardinisi Brumpt.
(Streptothriz sp. de Berardinis, And
Ottalmol. Lavori Clin. Oculist. Napol.,
33, 1901, 914; Actinomyces de Berardinis,
Namyslowski, Cent. f. Bakt., I Åbt,
Orig., 62, 1912, 560; Brumpt, Précis de
Parasitol., Paris, 3rd ed., 1922, 977;
Åctinomyces bernardinisi Brumpt, töd;
Åth ed., 1927, 1189; Nocardia berardinis
Vuillemin, Encyclopédie Mycologique,
Paris, 2, 1931, 125.) From a case of
keratitis.

Discomyces brasiliensis Lindonberg (Lindenberg, Rov. med. de S. Paolo, 1909, No. 18, and Arch. de Parasid., 15, 1909, 265; Nocardua brasiliensis Pinoy, Rull. Inst. Past., Paris, 11, 1913, 396; Streptothris brasiliensus Greco, Origine des Tumeura, 1916, 724; Oaspon brasiliensis Sartory, Champ. Patss Homme et Anim., 1923, 786; Actinonyca brasiliensis Gomes, Ann Palistas Med Cirurg., 14, 1923, 150.) From a case of mycetoma of the leg. According to Punoy and others, idential with Nocardia asteroides.

Discomyces congolensis Baerts (Baerts, Bull, Méd. Katanga, 2, 1925, 67, Ach nomyces congolensis Brumpt, Précis de Parasitol., Paris, 4th ed., 1927, 1926) From lesious in a case of actinomycess from the Belgian Congo.

Discomyces dispar (Vidal) Brumpt (Alterosporon dispar Vidal, 1882, Mersporon anemoen Vidal, 1882 and Sporterchum dispar, quoted from Brumpt, Précis de Parasitol, Paris, 3rd có., 1923 55 and from Nannuzi, in Pollact. Tratt. Micopat. Umana, 4, 1934, 25, Brumpt, 1dem; Actnomyces dipor Brumpt, 18dd, 4th ed., 1927, 1298)

From a case of pityriasis Species dubia

Discomptees mexicanus Boyd and Crutchfield, (Boyd and Crutchfield, Amer Jour Trop. Med, 1, 1921, 268, Actinomyces mexicanus Brumpt, Précis de Parastol, Paris, 4th ed, 1927, 1192; Nocardia mexicana Ota, Jap Jour Derm. Urol, 28, 1923.) From a mycetoma of the foot.

Discomyces minutissimus (Burchardt) Brumpt (Microsporon minulissimum Burchardt, in Uhle and Wagn Pat Gen . 1859; Trichothecium sp J. Neumann, 1868. Microsporon gracile Balzer, Ann. Derm Syphiligr., II, 4, 1883, 681; Sporotrichum minutissimum Saccardo, Sylloge Fungorum, 4, 1886, 100, Microsporoides minutissimus Neveu-Lemaire, Precis Parasitol, 1906, Brumpt, Précis de Parasitol, 1st ed., 1910, 863; Oospora minutissima Ridet, Oospora et Oosporoses. 1911, 68; Nocardia minutissima Verdun, Précis parasitol., 1912: Actinomyces minutissimus Brumpt, abid . 4th ed , 1927, 1199 ) Reported as the etiological agent of erythrasma

Mycobacterium alluvialum Bergey et al (Kersten, Cent. f Bakt., I Abt., Orig., 51, 1909, 494; Bergey et al., Manual, lat. ed., 1923, 379) From soil

Mycobacterium consolutum Gray and Thornton (Gray and Thornton, Cent f Bakt, II Abt, 73, 1928, 87; Actinomyces contolutus Bergey et al., Manual, 3rd ed., 1930, 473.) From soil. Resembles Nocardia onaca.

Nocardia arborescens (Edington) Trevisan. (Bacillus arborescens Edington, Brit Med. Jour, June 11, 1887, 1202, Trevisan, I generic le specie delle Batteriacee, 1889, 9; Actinomyces arborescens Gasperini, Cent. f. Bakt., 16, 1891, 641) From human skin in cases of scardatina.

Nocardia bahiensis da Silva (Da Silva, Brasil Med, 33, 1919, 81 and Mem. Inst. Butantan, 1, 1918-1919, 187, Discompres bahiensis Neveu-Lemaire, Précis de Parastol. Hum., 5th ed., 1821, 44, Oospora bahiensis Sartory, Champ. Paras. Homme et Anim., 1923, 784; Actinomyces bahiensis Brumpt, Précis de Parasitol., 4th ed., 1927, 1195.) From an actinomycotic mycetoma in Brazil.

Nocardia berestneff. Chalmers and Christopherson (Streptothrix cas I, II, Berestneff, Inaug. Diss, Moscow, 1897; Chalmers and Christopherson, Ann. Trop Med. and Parasitol, 190, 1916, 203; Discomyces berestneffi Brumpt, Précis de Parasitol, Paris, 3rd ed., 1922, 992; Actinomyces berestneffi Sartory and Bally, Mycoses pulmonaires, 1923, 250. From a case of pulmonary pseudotuberculosis

Nocardia bicolor (Trolldenier) de Mello and Fernandes. (Actinomyces bicolor Trolldenier, Ztschr. I. Tiermedizin, 7, 1903, 81; de Mello and Fernandes, Mem. Assatie Soc. Bengal, 7, 1919, 196.) Found in cerebromeningitis, bronchitis and lymphadenitis in a doc.

Necardia consoluta Chalmers and Christopherson, Chalmers and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 257, Discomyces conrolutus Noveu-Lemairo, Précis Parasitol Hum., 5th ed., 1921, 41; Oaspora conrolutus Sartory, Champ. Paras Homme et Anim, 1923, 769; Actinomyces contolutus Brumpt, Précis de Parasitol, Paris, 4th ed., 1927, 1195) From a yellow grain mycetoma of the foot in the Sudan.

Necardia cylindracea de Korté. (De Korté, Ann Trop. Med. Parasit., 11, 1918, 205; Discompies cylindraceas Neveu-Lemaire, Prícis Parasitol. Hum., 5th ed., 1921, 41; Osepora cylindracea Sartory, Champ Paras Homme et Anim, 1923, 774, Actinomyces cylindraceus Brumpt, Précis de Parasitologie, Paris, 1th ed., 1927, 1206) From an infection of the outer ear, resembling mycetoma

Nocardia enteritidis (Pottien) Castellani and Chalmers. (Streptothrix enteritidis Pottien, 1902, according to Sanfelice, Cent. f. Bakt., I Abt., Orig., 36, sanfelicci Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51.) From fatal lesions in a rat.

Nocardia splenica Gibson. (Gibson, 1930, quoted from Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 50; Actinomyces splenica Nannizzi, udem.) From a case of splenomegalia.

Nocardia tenuis Castellani. (Castellani, Brit. Jour. Derm. Syphilis, 23, 1911, 341; Discomyces tenuis Castellani, Proc. Roy. Soc. Med., 6, Derm., 1912, 23; Cohnistreptothrix tenuis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 16, 1916, 273; Actinomyces tenuis Dodge, Medical Mycology, St. Louis, 1935, 715.) From cases of trichomycoss fava.

Nocardia valvulae Chalmers Christopherson (Streptothrix valvulae destruens bovis Luginger, Monats. f. prakt. Tierheilk , 15, 1904, 289; Chalmers and Christopherson, Ann. Trop. Med. and Parasit , 10, 1916, 263; Oospora valvulae destruens bovis Sartory, Champ. Paras. Homme et Anim., 1923, 788; Actinomyces valvularis Ford, Textb. of Bact., 1927, 211; Actinomyces valvulae Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51 ) From endocarditis in cattle

Oospora anaerobies Sartory. (Actinomyces sp Butterfield, Jour. Inf. Dis., 2, 1905, 421; Sartory, Champ. Parasit. Homme et Anim., 1923, 830, Actinomyces anaerobies Plaut, quoted from Dodge, Medical Mycology, St Louis, 1935, 717.) From pus from human lung

Oospora bronchialis Sartory and Levasseur. (Sartory and Levasseur, 1914, quoted from Noveu-Lemaire, Précis Parasitol Hum., 5th ed. 1921, 43; Actinomyces bronchialis Sartory, Bull. Sci. Pharm., 23, 1916, 12, Discomptes bronchialis Neveu-Lemaire, idem.) From sputum in a case of pulmonary cosporosis.

Oaspora buccalis Roger, Bory and Sartory. (Roger, Bory and Sartory, Bull. Mem. Soc. Méd. Hôp. Paris, 27, 1909, 319 and Compt. rend. Soc. Biol., 68, 1909, 301; Discomyces buccalis Brumpt, Précis de Parasitol., Paris, 1st ed., 1910, 861; Nocardno buccatis Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 869; Actionwyces buccatis Sartory and Bailly, Mycoses pulmonaires, 1923, 260). From a case of creamy stomatisis with tonsillar abscess.

Osspora caterhalis Sattory and Bailly. (Sartory and Bailly, Thèse Univ. Strabourg Fac. Pharm, 4, 1921, 57; Intended Caterhalis Brumpt, Prées de Parasitol., Paris, 3rd ed., 1922, 98; Actinomyces caterhalis Brumpt, Ibid., 4th ed., 1927, 1135.) From eputum is a case of pulmonary ossporosis.

Oospora hominis Ridet. (Streptothriz

appendicis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 266; Discompres appendices Brumpt, Précis de Parasitol., 37d ed., 1922, 97; Actinomyces appendices Brumpt, 10d., 4th ed., 1927, 1189.) From a case of appendicitis and an illiac abserss.

Osspora lingualis Guéguen. Guéguen, Compt. rend. Soc. Biol., 64, 1908, 832, Discomyces lingualis Brumpt, Précis de Parasitol., Paris, 1st ed., 1910, 865 and

3,

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mers and Christopherson, Ann. 1107 Med. and Parasitol., 10, 1916, 255. Discompces pueque il rumpi, 1504, 376 ed., 1922, 980; Actinomyces gurpen Brumpt, 1504, 4th ed., 1927, 1921, Vecardia guequeni Ota, Jap. Jour Dem Urol, 28, 1928.) From cases of lingus

nigra.
Oospora pulmonalis Roger, Seriory
and Bory. (Roger, Sattory and Bory.
Compt. rend. Soc. Biol., 66, 1909, 150,
Discomyces pulmonalis Brumpt, Précis

de Parasitologie, 1st ed., 1910, 860; Nocardia pulmonalis Castellan and Chalmers, Man Trop. Med., 2nd ed., 1913, 817; Actinomyces pulmonalis Sartory and Bailly, Mycoses Pulmonaires, 1923, 256.) From the sputum of a patient with pulmonary mycosis.

Osspora pulmonalis var. chromogena Sartory (Sartory, 1913; Actinomyces pulmonalis var. chromogenus Nannizz, in Pollacci, Tratt. Micopat Umana, 4, 1934, 39. From sputtum of a patient suspected of having pulmonary tuberculosis

Proactinomyces albus Krassilnikov. (Bull Acad. Sci., U. S. S. R., No 1, 1938, 139 ) Cells at first produce mycelium with frequent branching varying in diameter from 06 to 10 micron Breaks up after 2 or 3 days into rods and sometimes later into cocci. Multiply by fission, cross-wall formation and budding Does not form spores, cells are Gram-positive and are not acid-fast. Colorless growth Colonies vary in the different strains, somewhat rough, folded, shiny or dull, of a dough-like consistency. Krassilnikov listed several strains of this organism, including Proactinomyces oliaacarbaphilus

Proactinomyces aquosus Turfitt (Jour Bact , 47, 1941, 490 ) From soil Decomposes cholesterol

Prooctinomyees eyaneus (Beijerinek). Krassilnikov (Actinococcus eyaneus Beyerinek, Folia mierobiol., Delft. 4, 1914, 1905, Krassilnikov, Ioc. cit.) Blue pigment produced on synthetic media Cells are rod-shaped 0.7 to 0.8 by 3 to 7 microus. Branching cell material on potato multiphe by means of bud formation, by fission, and cross-wall formation; no true stores formed.

Proactinomyces evaneus-antibiolicus Gause (Jour. Bact, 51, 1916, 619) From soil Produces litmocidin, a new antibiotic

Proactinomyces moormani Franklin. (Ann Intern. Med., 15, 1910, 1205.) From the pus of multiple molar abscesses in a dental patient.

Proactinomyces paraguagensis Almeida. (Mycopath., 2, 1949, 201.) From a thoracie mycetoma with heavy, dark grains affecting a Canadian patient living in the Paraguayan Chaco. Sabouraud's glucoso agar. Pseudomembranous colony with raised, dark center surrounded by a white band, progressively increasing in size, and then by a light chocolate area.

Proactinomyces restrictus Turfitt. (Jour. Bact, 47, 1944, 491.) From soil. Decomposes cholesterol.

Proactinomyces sp. Helzer. Found in sputum of tuberculous patient. Pathogenic for guinea pigs and rabbits.

Streptothriz buccolis Goadby. (Mycology of the Mouth, London, 1803, 200.) From the mouth in cases of pyorrhoes. Chalmers and Christopherson (Ann. Trop Med. and Parasit, 10, 1916, 234) regard this as a synonym of Nocardia liquifactions

Streptothrix flata Chester. (Actinomyces sp Bruns, Cent. f. Bakt., 26,
1890, 11; Chester, Man Determ. Bact,
1901, 802; Nocardia brunt Chalmers and
Christopherson, Ann Trop. Med. and
Parasit., 10, 1916, 250; Streptothrix hominus Bruns, according to Chalmers and
Christopherson, 1dem; Discomyces bruni
Brumpt, Précis de Parasitol., Paris,
3rd ed, 1922, 992; Actinomyces bruni
Drumpt, told, 4th ed., 1927, 1204; Actinomyces facus Dodge, Medical Mycology, St. Louis, 1935, 752. Prom pus
from a case of actinomycess of the abdowneal wall.

Streptothrix Jusca Karwacki, (Karwacki, Compit rend, Soe, Biol., 62, 1911, 180, not Streptothrix Jusca Corda, Prachtiflora europäischer Schimmelbidungen, Leiping and Dresden, 1839, 27; Nocardia Jusca Castellani and Chalmers, Man Trop Med., 2nd ed., 1913, 518, Discompces Juscus Brumpt, Précis de Parasitol, Paris, 3rd ed., 1922, 903; Osspora Jusca Sartory, Champ. Paris.

Homme et Anim., 1923, 809; Actinomyces fuscus Sartory and Bailly, Mycoses pulmonaires, 1923, 256; not Actinomyces fusca Söhngen and Fol, Cent. f. Bakt., II Abt., 40, 1914, 87.) From the sputum of a tuberculosis patient.

Steptothriz luteola Foulerton and Jones. (Foulerton and Jones. (Foulerton and Jones, Trans. Path. Soc. London, 53, 1902, 75; also see Foulerton, Lancet, 1, 1905, 1200 and 1, 1906, 970; Nocardia luteola Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 818; Discomyces luteolus Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 981; Oospora luteola Sartory, Champ. Paras. Homme et Anim., 1923, 812; Actinomyces luteolus Ford, Textb. of Bact, 1927, 213.) From a lung infection, from a case of conjunctivities, and from a dental abscess.

Streptethriz madurae Solari. (Solari, Semana Méd., 24, 1917, 573; not Streptothriz madurae Vincent, Ann. Inst. Past., 8, 1894, 129; not Streptothriz madurae Koch and Stutzger, Ztschr. f. Hyg, 69, 1911, 17.) From Madura foot. See Actnomyces gradi.

Streptothriz muris-ratii Schottiniller. (Schottmüller, Derm. Wochnesch., 68, 1914, 77; Nocardia muris de Mello and Pais, Arq. Hig. Pat. Evot., 6, 1918, 183; Actinomyces muris-ratii Nanniri, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 51.) From sodoku or rat-bite fever.

Streptothrix tarozzii Miescher. (Actinomyces albus Tarozzi, Archivo Sci. Med., 35, 1909, 553; Miescher, Arch. Derm. Syphilis, 124, 1917, 297; Actinomyces tarozzii Dodge, Medical Mycology, St. Louis, 1935, 735.) From a case of Madura foot.

Streptothriz verrucosu (Adler) Miescher. (Actinomyces verrucosus Adler) Nonziezi, 1901, see Namizzi, in Pollacci, Tratt. Micopat Umana, 4, 1934, 46; Miescher, Arch Derm. Syphilis, 123, 1917, 314.) From mycetoma pedis

#### Canus II Actinomyces Harr

(Har, in Bollinger, Centbl. f. med. Wissensch., 15, 1877, 485; Harz, Jahresber. d. Munch. Thierarzneischule for 1877-78, 1879, 123; not Actinomyee Meyen, Linnaca, 2, 1827, 442; Discomyees Rivolta, Clinica Veter, Milsno, 1, 1878, 203; Actinocladothrix, Afanssiev, St. Petersb. med. Wchaschr., 4, 1887, 323; Micromyees Gruber, Cent. f. Bakt., 10, 1819, 648; not Micromyees Dangard, Le Botaniste, 1, 1888, 55; Actino-bacterium Hass, Cent. f. Bakt., 17, Abt., Orig., 40, 1906, 180; Carteria and Carterii Musgrave, Clegg and Polk, Philippine Jour. Sei. Ser. B., Med. Sci., 5, 1003, 470; Cohnisteptuhriz Pinoy (in part), 1911, see Pinoy, Ball. Inst. Past., 171, 1913, 202; Anacromyces Castellani, Douglas and Thomson, Jour. Trop. Med. Hyg., 24, 1921, 1493. Recessferelabiliz Lieniers. Ann Parasit Hum Comp. 2, 1924, 1909.

True mycelium produced. The vegetative mycelium fragments into elements of irregular size and may exhibit angular branching. No conidia produced. Not acidfast. Anseroble to microaerophile. Pathocenic for man and animals.

The type species is Actinomyces bovis Harz.

## Key to the species of genus Actinomyces.

- Colonies soft, smooth, uniform, not adherent to medium. No aerial hyphae.
   Actinomyces boxis.
- II Colonies tougher in texture and warted in appearance, adherent to medium. Scanty acrual growth of hyphae.
  - 2. Actinomuces israeli.

1. Actinomyces boyls Harz. (Harz. on Bollinger, Cent. f. med. Wissensch., 15. 1877, 485; Jahrb d. Münch, Thierarzeneischule, 1877, 781; Discomuces boris Rivolta, La clinica Veterinaria, 1, 1878, 169 or 203; Bacterium actinocladothriz Afanasiev. St. Petersburger Wochnschr., 15, 1888, 84; Nocardia acunomuces Trevisan. I generi e le specie delle Batteriscee, Milan, 1889, 9; Streptotrix actinomyces Rossi Doris, Ann. d. Ist d'Igi Sper., Univ di Roma, 1, 1891. 125. Claduthriz bons Macé. Traité de Bact., 2nd ed , 1891, 666; Ocepora boris Survegeau and Radais, Ann. Inst. Past., Paris, 6, 1892, 271; Actinomyces bovis sulphureus Gasperini, Cent. f. Bakt., 15. 1891, 681; Nocardia boris Blanchard. in Bouchard, Traité de Path. Générale, 2. 1896. 857; Actinomyces sulphureus Gasperini, Atti Soc. Tosc. Scienz. Nat., P. V , 11, 1896; Cladothriz actinomuces Macé. Traité de Bact., 3rd ed., 1897, 1038. Streptothriz actinomycotica Poulerton, Lancet, 2, 1809, 780, Streptothriz boris communis Poulerton, Jour. Comp. Path, and Therap., 14, 1901, 50; Streptothriz bous Chester, Man. Determ Bact., 1901, 361, Steptolthriz sulphurea Caminiti, Cent. f. Bakt., 1 Abt., Orig. 44, 1907, 197; Sphaerotilus boris Engler, Syllabus der Pflanzenfam., 5 Aufl., 1907, 5; Nocardis sulphurea Vuillemin, Encyclopédie Mycologique, Paris, 2, 1931, 129; Proactinomyces boris Henrici, Biology of Bact., 2nd ed., 1939, 409.) From Latin boris, of the or.

Synonyms previous to 1919 as given by Breed and Conn, Jour. Bact., 4, 1919, 596.

Probable synonym: Brevistreptothrix spitti Lignières, Annales de Parasit , 2, 1934, 2 (Streptothrix spitti Lignières and Spitz, Cent. f. Bakt, I Abt., Orig, 55, 1904, 453, Actinobecterum ésreul: var. spitti Sampietro, Ann. Iguene, 18, 1938, 291; Discompetes spitti Brumpt, Peccis de Parasitol, Paris, 1st ed., 1910, 817, Actinomyces spitti Heske, Morphol. u. Biol d Strahlenpilee, Leipzig, 1924, 23; Osspora spitti Sartory, Champ. Paras Homme et Anim, 1923, 753. Found in mycosis of the upper jaw of onen in Argentian.

Description from Erikson, Med. Res. Council, London, Special Report Scr. 240, 1940, 63 pp

No aerial hyphae. Radiate, sulturcolored granules occur in the pus found in cases of actinomycosis. Large clubshaped hyphae are seen in morbid tissues. Gram-positive. Non-motile. Not acidfast.

Mycelium: Undergoes fragmentation very rapidly, extensive branching is rare. Hyphae less than I micron in diameter.

Colonies: Smoother and softer in consistency, and more uniform than in the following species. The colonies are not adherent to the medium and growth is scantier.

Semi-solid media: Excellent growth, especially with paraffin seal.

Gelatin Occasionally scant, flaky growth. No liquefaction.

Liquid media Occasional turbidity with a light flocculent growth,

Acid from glucose, sucrose and maltose. No acid from salicin and mannitol

Pigments No soluble pigments produced on protein media. No insoluble pigments produced by growth.

Egg or serum media. No proteolytic

Litmus milk Becomes acid but usually no congulation, no pertonization. Sometimes no growth

No hemolysis in blood broth or blood agar.

Scrology No cross agglutination between five bovine strains and human strains of Actinomyces israeli No cross reactions with representative aerobic strains

Optimum temperature 37°C

Anaerobic to microaerophilic. Bovine strains are more oxygen-tolerant on egg or serum media than strains of human origin belonging to the following species

As pointed out by Lignières and Spitz (Bull Soc. cent Méd. vet, 20, 1902, 487 and 546) and others, distinction should be made between the infections produced by Actinomyces boils and those produced by the Gram-negative Actinobacillus now known as Actinobacillus lignierat. These infections frequently occur in mixed form and are also frequently complicated by the presence of progenic cocci (Magnussen, Acta path. Microbiol. Scand., 5, 1928, 170; and others).

Source: Originally found in lumpy jaw of cattle

Habitat: Frequently found in and about mouth of cattle and probably other animals. Lesions may also be produced in the liver, udder or other organs of cattle and hogs. Possibly also in human mouth (Naeslund, Acta path. Microbiol. Scand., 2, 1923, 110).

This and the following species are sometimes regarded as being identical (see Emmons, Public Health Repts, U.S.P.H.S., 53, 1935, 1967; Rosebury, Bact. Rev., 8, 1944, 190; and others).

2. Actinomyces israell (Kruse)
Lachner-Sandoval. (Strablenpils, Wolfs
and Israel, Arch. f. path. Anat., 126,
1891, 11; Streptothriz israeli Kruse, in
Flugge, Die Mikroorganismen, 3 Auf. 2,
1895, 65; detinomyces israeli IschnerSandoval, Inaug. Diss., Strasburg, 1898,
64, Discomyces israeli Gedoelst, Ise
champignons parasites de l'homme et
des animaux domestiques, 1902, 163;

ur,

Paris, 11, 1913, 931; Nocarda ssudil Castellani and Chalmers, Man. Trop. Med. 2nd ed., 1913, 814; Anaeromyces bronchitica Castellani, Douglas and Thomson, Jour Trop. Med. Hyg., 24, 1921, 149; Cohnisterplothrix bronchitica Verdun and Mandoul, Précis Parasitol, 1924, 754; Breusterplothrux israeli Lignières, Annales de Parasit., 8, 1924, 2; Proactinomyces israeli Negroni, Compt. Fed. Soc. Biol., Paris, 117, 1934, 1239; Corynebacterium israeli Haupt and Zeki, Cont. I. Bakt., I Abt., Orig., 150, 1933, 955, Oospora teraeli, quoted from Nannizi,

Tratt. Micopat. Umana, 4, 1934, 53; Actinomyces wolff-israel Lentze, Cent. f. Bakt, I Abt., Orig, 141, 1938, 21.) Named for Prof. Israel, one of the original isolators of this organism

Synonyms previous to 1919 essentially as given by Breed and Conn, Jour. Bact, 4, 1919, 597.

Description from Erikson, Med. Res Council, London, Special Rept Ser 240, 1940. 63 pp.

Erect serial hyphae produced in an atmosphere of reduced oxygen tension These hyphae are occasionally septate but no definite spores are formed. One micron or more in diameter. Large club shaped forms are seen in morbud tissues. Gram-positive, Non-motile Not scilidate.

Substrate mycelium: Initially uniceilular and the branches may extend into the medium in long filaments or may, more or less quickly, exhibit fragmentation and characteristic angular branching The latter resembles the similar phenomenon found in Corynchacterium.

Colonies. These exhibit a considerable degree of polymorphism but no stable variants have been established. Tougher in texture than those of Actinomyces boris. Old colonies warted in appearance Adherent to the medium.

Gelatin. Occasionally scant, flaky growth. No liquefaction,

Liquid media: Usually clear.

Acid from sugars. According to Slack (Jour Bact., 43, 1911, 193-200) said from glucose, maltose, mannitol, sucrose and lactose; according to Negroni and Bonfiglioil (Physics, 15, 1933, 159) acid from glucose, galactose, lactose, fructose, maltose, raffinose, sucrose and vylose

Pigments: No soluble pigments on protein media. No insoluble pigments produced by growth.

Egg or serum media. No proteolytic action

Litmus milk : Becomes acid but usually

does not clot. No peptonization. Fre-

quently no growth No hemolysis.

No hemolysis.

Serology: No cross agglutination between 12 human strains and bovine strains of Actinomyces. No cross reactions with representative acrohic strains.

Optimum temperature 37°C.

Source: From 2 cases of human actinomycosis (1) A retromaxillary tumor, (2) actinomycosis of lung and breast (Wolff and Isreal)

Habitat From human sources (mouth, tonsillar crypts, etc.). Also reported from various domestic animals such as dogs (Baudet, Ann. Parasit., 12, 1934, 296) and cats (Edington, Vet. Record., 14, 1934, 311).

Appendix: The following names have been applied to an aerobic or semi-an aerobic species, with descriptions which do not permit clear separation from the above or from each other.

Actinobacterium meyeri Prévot. (Anaerobe Streptothrix-Art, Meyer, Cent. f Bakt, I Abt., Ong, 60, 1911, 75, Prévot, Ann Inst. Past, 60, 1938, 303) From fettd nus

Actinomyces discofolialus Grüter. (Grüter, Zischr t. Augenheilk, 18, 1933, 477, redescribed by Negroni, Mycopathologia, 1, 1938, 81) From lachrynal concretion and human infection

Actinomyces Instranchis Sani (Sani 1216, quoted from Dodge, Medical Mycology, St. Louis, 1935, 731, Novarda Instranchis de Mello and Pass, Arq. Hig. Pat. Evot., 6, 1918, 178). From glandular and gauglionar actinomycosis of the ox. Regarded as a variety of Actinomyces boxts.

Actinomyces thoetics Dodge. (Cohn.).

Actionmers in justice Dougle, (Connistreptothriz sp or Streptothriz sp. Thjøtta and Gundersen, Jour. Bact., 10, 1925, 1, Dodge, Medical Mycology, 1935, 713) I from the blood in a case of acute theumatism Cohnistreplothrix neschezadimenki (sic) Chulmers and Christopherson. (Eine Streptothrix, Neschezadimenko, Cent. I. Bakt., I Abt., Orig., 46, 1908, 573; Chalmers and Christopherson, Ann. Trop. Med., 10, 1916, 273; Actinomyces neschezadimenki Dodge, Medical Mycology, 1935, 712; Actinobacterium abacessus Prévot, Ann. Inst. Past., 60, 1938, 303.) From a human infection.

Discomyces carougeaui Gougerot. (Gougerot, Compt. rend. Soc. Biol., Paris, 67, 1909, 580; Nocardia carougeaui Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 817; Cohnistreptatriz carogeanui (sic.) Chalmers and Christopherson, Ann. Trop. Med., 10, 1916, 273; Streptothriz carougeaui Greco, Origine des Tumeurs, 1916, 724; Actinomyces carougeaui Brumpt, Précis de Parasitol., 4th ed., 1927, 1200) From a human infection.

Discomyces thibiergei Ravaut and Pinoy (Ravaut and Pinoy, Ann. Derm. et Syph., 10, 1900, 417; Nocardia thibiergei Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 817; Cohnstreptothriz this teprejer Pinoy, Bull. Inst. Past., 11, 1913, 933; Osapra this tepres Sartory, Champignons Parasites de Pilomme et des Animaux, Fasc. 11, 1920, 792; Actinomyces this terget Greco, Origine des Tumeurs, 1916, 723.) From a human infection.

Streptothrix cuniculi (Schmorl, Doutsch, Ztschr. f. Thiermed. 17, 1891, 375; Actinomyces cuniculi Gasperini, Ann. Ist. Ig. sper. Univ. Roma, 2, 1892, 222; Cladothrix cuniculi Macé, Traité de Bact., 6th ed , 2, 1913, 753; Cohnistreptothriz cuniculi Chalmers and Christopherson, Ann. Trop. Med, 10. 1916, 273; Nocardia cunicula Froilani de Mello and Fernandes, Mem. Asiatic Soc. Bengal, 7, 1919, 107; Oospora cuntculs Sartôry. Champignons parasites de l'Homme et des Animaux, Fasc. 11, 1923, 824.) From infections in rabbits. Generally regarded as probably identical with Spherophorus necrophorus (Flügge) Prévot. See page 678.

# FAMILY III. STREPTOMYCETACEAE WAKSMAN AND HENRICI.

(Jour. Bact., 46, 1943, 339.)

Vegetative mycelium not fragmenting into bacillary or coccoid forms. Conidia borne on sporophores. Primarily soil forms, sometimes thermophilic in rotting manure A few species are parasite.

### Key to the genera of family Streptomycetaceae.

I. Conidia produced in aerial hyphae in chains.

Genus I. Streptomyces, p 929.

II. Conidia produced terminally and singly on short conidionhores.

Genus II. Micromonospora, p. 978.

# Genus 1 Streptomyces Walsman and Henrici.

(Streptolhriz Cohn, Bettr. zur Biol der Pflanzen, I. Heft 3, 1875, 185; not Streptolhriz Cords, Prachtflora Europeascher Schimmelbildung, 1839, Nocardia Wright, Jour. Med. Research, 15, 1905, 349; Nocardia Winslow et al., Jour. Bact, £, 1917, 554; not Nocardia Trevisan, I genere ele specie delle Batteriacee, 1889, 9; Cahnitreptolhriz (Group i) Orskov, Investigations in the Morphology of the Bay Fung: Copenhagen, 1923, 147; not Cohnistreptolhriz Prinoy, in Liégard and Landrieu, Bull Soc. Opht, 24, 1911, 233 and Bull Inst. Past., 11, 1913, 292; Aerothriz Wollenweber (in part), Ber deut. Bot Gesel, 39, 1921, 20; Liucationopieze Langeron (in part), Nouv. Traité de Méd., 4, 1922, Walsman and Henrici, Jour. Bact., 46, 1913, 339)

Organisms growing in the form of a much-branched mycelium with a typical aerial mycelium. Condiospores formed in chains. Aerobic. Saprophytic soil forms, less commonly carastic on plants or animals.

This genus can be divided, on the basis of the structure of sporulating hyphac, into five groups

Group 1 Straight sporulating hyphae, monopodial branching, never producing

regular spirals.

Group 2. Spore-bearing hyphae arranged in clusters.

Group 3. Spiral formation in serial mycelium; long, open spirals.

Group 4. Spiral formation in serial mycelium; short, compact spirals.

Group 5 Spore-bearing hyphae arranged on mycelium in whorls or tufts.

The type species is Streptomyces albus (Rossi Doria emend Krainsky) Walsman and Henrici

# Key to the species of genus Streptomyces.

I Saprophytes; psychrophilic to mesophilic.

A. Soluble pigment on organic media faint brown, golden-yellow, or blue; pigment may also be absent entirely.

 Pigment absent, or faint brown pigment formed at first and later lost; aerial mycelium abundant, white

1. Streptomyces albus.

2 Pigment blue or red, when present. The red (insoluble) phase occurs when the reaction is distinctly acid, the blue (soluble) phase when it is alkaline

2. Streptomycer coelicolor.

Revised by Prof. S. A. Walsman, New Jersey Experiment Station, New Brunswick, New Jersey and Prof. A. T. Henrici, University of Minnesota, Minnesota, Minnesota, May, 1943.

- 3. Pigment at first green becoming brown; aerial mycelium usually sheent
  - 3. Streptomuces verne.
- 4. Pigment yellowish-green; growth on synthetic agar penetrating into medium, pink.
  - 4. Streptomyces californicus.
- 5. Pigment golden-yellow; growth on synthetic agar yellow, with yellow soluble pigment.
  - 5. Streptomyces flaveolus.
- 6. Pigment brown (only on certain protein media, as gelatin, glucose broth).
  - a. Grown on synthetic agar red to pink. Scant, white serial mycelium.
    - 6. Streptomyces bobiliae.
  - aa. Growth on synthetic agar colorless; aerial mycelium thm, rose-colored.
    - 7. Streptomuces roseochromogenus.
  - asa. Growth on synthetic agar mouse-gray; powdery serial mycelium
    - 8. Streptomyces griscolus.
  - asas. Growth on synthetic agar white turning yellowish, aerial mycelium white.
- 9. Streptomyces erythreus.
- B. Soluble yellow pigment on Ca-malate agar.
  - 1. Proteolytic action strong in milk and gelatin.
    - a. Yellow pigment formed.
      - b. Cellulose decomposed: starch is hydrolyzed.
        - 10. Streptomyces cellulosae
      - bb. Cellulose not decomposed.
  - 11. Streptomuces parvus. 2. Proteolytic action weak,
- 12. Streptomyces malenconi.
- C. Soluble brown pigment formed on synthetic agar.
  - 1. Yellowish-green pigment on potato.
  - 13. Streptomyces diastaticus
  - 2. Red-brown pigme at on potato plug. 14. Streptomyces fimicarius.
- D. Greenish-yellow solul le pigment formed; sulfur-yellow pigment on pointo. 15. Streptomuces flavorirens.
- E. Soluble brown pigment formed in all media containing organic substances
  - Pigment deep Brown (chromogenic type).
    - a Pigment faint brown on organic media, becoming greenishbrown to black, reddish aerial mycelium on glucose agur. 16 Streptomyces olivochromogenus.
    - aa. Aerial mycelium yellowish with gray margin; weak diastatic
    - action. 17. Streptomyces diastatochromogenes.
    - aaa. Aerial mycelium yellowish; diastatic action weak.
    - 18. Streptomyces flavochromogenes. anna. Aerial my lium gray; sporophores in clusters; strongly anti-
      - 19. Streptomyces antibioticus.

- 2. Growth and aerial mycelium green on synthetic agar. 20. Streptomuces viridochromogenes.
- 3. Deep brown to black pigment on synthetic agar.
  - a. Orange-red on potato, no serial mycelium on synthetic agar: growing feebly 21. Streptomuces nurneochromogenus.
  - aa. Brown to black on potato; abundant cottony aerial mycelium
  - on synthetic agar b. Brown ring on milk culture; coagulated; peptonized
    - 22. Streptomyces phaeochromogenus
    - bbb. Black ring on milk, no coagulation; pentonization doubtful
      - 23. Streptomyces aureus,
      - el. Red to rose-red pigment on glucose, maltose, and starch agar.
        - 24. Streptomuces eruthrochromogenes.
        - c2. Lavender-colored serial mycelium. 25. Streptomyces latendulae
        - c3. Growth on potato gray with black center.
        - 26 Streptomyces reticuli.
        - c. Growth on potato cream-colored, becoming pink to dark red.
          - 27 Streptomyces rubrireticuli.
        - cs. Growth on potato greenish-olive
          - d Aerial mycelium straw-colored
          - 28 Streptomuces flavus. dd. Aerial mycelium chrome-orange,
          - 29. Streptomuces ruber.
- F No soluble pigment formed on gelatin or other media,
  - 1. Proteolytic action strong in milk and gelatin.
    - at Yellowish-green growth on starch with pinkish aerial invectium 30. Streptomuces citreus
    - at Golden-yellow growth, later becoming orange to red-brown, on synthetic media
    - 31 Streptomuces fulrissimus
    - a. Cream-colored growth on starch media 32. Streptomyces gougeroli.
    - a4. Bluish-black color on synthetic media, with white aerial mycelium.
      - 33 Streptomyces violacconiaer
    - a. Yellowish pigment on potato. b. Aerial mycelium thick, powdery, water-green; starch is bydrolyzed
      - 31. Streptomyces griseus.
      - bb. Aerial mycelium white; starch weakly hydrolyzed.
      - 35. Streptomyces griscoflarus. at. Greenish-black pigment on potato; aenal mycelium white.
    - 36 Streptomyces albidoffarus. a7. Reddish-brown pigment on potato; serial mycelium white: starch is not hydrolyzed
      - 37 Streptomyces poolensis.

399; Cladothriz alba Macé, Traité Pratique Bact., 37a ed., 1897; Actinomyces albus Krainsky, Cent. f. Bakt., 11 Abt., 44, 1914, 662; Nocarda alba Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270; Waksman and Henrici, Jour. Bact., 46, 1913, 339.) From Latin albus. white.

Additional synonyms as given by Baldacci (Mycopathología, 2, 1940, 156): Cladethrix dichotoma Macé, not Cohn. 1886: Streptothrix foersteri Gasperini, not Cohn, 1890; Streptothrix No. 2 and S. Almquist, 1800; Actinomyccs saprophyticus Gasperini, 1892; Oospora doriae Sauvageau and Radais, 1892; Cladothriz liquefacions Hesse, 1892 (according to Duché); Cladothriz invulnerabilis Acosta and Grande Rossi, 1893; Actinomuces chromogenus Gasperini, 1894 (Streptotrix nigra Rossi Doria, 1891); Streptoaedanensis I Scheele Petruschky, 1897; Streptothrix graminearum Berestneff, 1898; Actinomyces thermophilis (Berestneff) Miche, not Gilbert, 1898: Cladothrix odorifera Rullmann. 1898: Actinomuces chromogenes Gasperini 8 alba Lehmann and Neumann, 1899; Oospora sp. Bodin, 1899 (according to Duché); Oospora alpha Price-Jones. 1900 (according to Chalmers and Christopherson): Streptothriz leucea Foulerton, 1902 (according to Chalmers and Christopherson): Streptothriz candida Petruschky, 1903; Streptothrix lathridii Petruschky, 1903: Streptothrix dassonrillei Brocq-Rousseau, 1907 (according to Duché); Streptothrix pyogenes Caminiti, 1907 (according to Chalmers and Christopherson): Streptothrix sanninii Ciferri, 1922; Actinomyces almquisti Duché, 1934; Actinomyces gougeroti Duché, 1934. Doubtful synonyms: Oospora metchnikowi Sauvageau and Radais, 1892; Oospora guignardi Sauvageau and Radais, 1892; Actinomyces albus Waksman and Curtis, 1919; Actinomyces thermodiastaticus Bergey, (1919) 1925. Varieties: Actinomyces albus var acidus Neukirch, 1902 (according to Nannizzi); Actinomyces albus var. ochroleucus Neukirch, 1902 (secording to Wolleameber); Actinomyces albus var. toxica Ross, 1905; Actinomyces albus var. cretaceus (Krūger) Wolleameber, 1920; Actinomyces albus var. a Ciferri, 1927.

More complete information regarding these species will be found in the text or

in the Appendix to Genus Streptomyces.

The description of this species by Rossi Doria is incomplete. The chancters given below are taken from Krainsky (loc. cit.) with some supplementary information from later authors. Other descriptions which may vary from this in certain details are given by Waksman and Curtis (Soil Sci., 1, 1916, 117), Berger et al. (Manual, 1st cd., 1923, 357), Duché (Les actinomyces du groupe albus, Paris. 1934, 257) and Baldsacei (loc et ).

Vegetative hyphae: Branched, I micron

n diameter

Aerial mycelium: Abundant, white. Hyphae 1.3 to 1.7 microns in diameter with ellipsoidal spores (1 micron long) in coiled chains on lateral branches of the aerial hyphae.

Gelatin: Liquefaction. Colonies gray,

no soluble pigment.

Ca-malate agar: Colonies of medium size, the center only is covered with a white aerial mycelium.

Starch agar: Aerial taycelium white but covers the whole strface.

Glucose agar: Gray serial mycelium becoming brownish.

Peptone and bouillon agar: No aerisl mycelum but a chalky white deposit forms on old colonies.

Odor: Earthy or musty.

Broth: Flaky growth on bottom with surface pellicle in old cultures.

Potato: Colonies and aerial mycelium

white.

Carrots and other vegetables: Excellent growth (Duché).

No growth on cellulose. No hydrolysis of starch. Actively proteolytic.

Nitrites produced from nitrates.

Milk: Peptonized after coagulation. Reaction becomes alkaline (Duché).

Aerobic.
Source: From air and soil (Rossi
Dona); from garden soil (Krainsky).
Habitat Dust, soil, grains and straw.
Widely distributed.

2 Streptomyces coelicolor (Reiner-Muller) comb. noc. (Streptothriz coelicolor Renner-Muller) comb. noc. (Streptothriz coelicolor Renner-Muller) comb. noc. 1984; 1 Abt., Orig., 46, 1908, 197, Nocardia coelicolor Chalmers and Christopherson, Ann Trop. Med. and Parasit, 10, 1916, 271; Actinomyces coelicolor Licešae, Morphol u. Biol d. Strahlenpiles, Leipsig., 1921, 23) From Latin carlium, sky and color, color.

Regarded by the authors of this section as the same as Actinomuces violaceus Wakeman and Curtis Soil Science 1 1916. 110 (Actinomuces malaceus-ruber Waksman and Curtis, ibid , 127, Actinomuces makemanti Bergey et al . Manual. 3rd ed . 1930, 489) and Actinomyces tricolor Wollenweber, Arbeiten d Forschungsinstitut für Kartoffelbau. 1920. It is, however, pointed out by J. E. Conn (Jour. Bact . 46, 1913, 133) that certain differences between the descriptions of Waksman and Curtis, and that of Muller may correspond to actual chemical differences in the pigments produced; and that the organism of Waksman and Curtis may be a separate species.

Description by Müller except as

Morphology of Streptomyces cocicelor has not been fully described. According to Waksman and Curtis who described Actinomyces violaccus-ruber, this is as follows: Straight filaments with open, dextro-se spirals, breaking up into conidia Conulia oval or red-shaped, 0.7 to 1.0 by 0.8 to 1.5 microns.

Gelatin Good growth. No pigment formation Liquefaction fairly rapid, becoming in 4 to 7 days.

Plain agar: Good growth. Pigment lacking or faint blue (Conn). Czapok agar (according to Waksman and Curtis concerning Actinomyces violaceus-ruber): Thin, spreading, colorless at first, becoming red, then blue. Aerial mycelum thin, white, powdery, becoming mouse-gray.

Asparagine agar (synthetic). With glycerol as source of earbon, good growth, violet to deep blue, with pigment diffusing through medium; final H-on concentration about pH 7.0 to 8.0. With glucose as source of carbon, poorer growth, red, no diffusion of pigment; final H-ion concentration about pH 60 to 50 (Conn).

Broth. Good growth. Cretaceous layer around edge.

Milk. No change at 25°C (Conn), At 37°C, congulation Peptonization beginning in 3 to 5 days.

Potato. Strong pigment production, sometimes greenish-blue or violet, but usually sky-blue, diffusing through medium and coloring water at base of tube. Nitrites produced from nitrates.

Blood agar; Hemolysis showing on 4th

Muller reports no acid from carbohydrates on organic media. Conn, however, finds acid from glucose and lactose, and sometimes from sucrose and mannitol when grown on synthetic media.

Plement: The most striking characteristic of this organism is a litmus-like niement usually produced on potato or synthetic media, which is deep blue and water-soluble at alkaline reactions (beyond pH 80), violet around neutrality. and red (insoluble in water) at about pH 60. Conn points out that the primary pigment has a spectrophotometric curve almost identical with that of agolitmin : but that there are undoubtedly other pigments produced, especially in the case of the strains believed to be typical of Actinomyces violaceus ruber fas previously pointed out by Walsman and Curtis).

Good growth at room temperature and at 37°C.

Optimum temperature 37°C. Habitat: Soil.

 Streptomyces griseoius (Waksman) comb. noc. (Actinomyces 96, Waksman, Soil Science, 8, 1919, 121; Actinomyces griseoius Waksman, in Manual, lat ed., 1923, 369.)
 From Latin griseus, gray and colus, diminutive ending; hence, somewhat gray.

Branching mycelium; no spirals observed. Conidia spherical or ovalshaped.

Gelatin stab: Liquefied with yellowish, flaky pellicle and sediment.

Synthetic agar: Colorless, thin, spreading growth, chiefly in the medium; surface growth limited almost entirely to the aerial mycelium. Aerial mycelium at first gray, later becoming pallid, neutraleray.

Starch agar: Grayish-brown growth,

with dark ring.

Glucose agar Spreading growth, both on the surface and into the medium; center raised, cream-colored, turning dark.

Plain agar: Brownish growth, with smooth surface.

Glucose broth Thick, brown ring.

Litmus milk: Abundant growth, pink pellicle; coagulated; peptonized, becoming alkaline.

Potato: Cream-colored growth, becoming black, spreading

Nitrites produced from nitrates.

Faint brownish soluble pigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat : Soil.

 Streptomyces crythreus (Waksman) comb. nov. (Actinomyces 161, Waksman, Soil Science, 8, 1919, 112; Actinomycs crythreus Waksman, in Manual, 1st cd., 1923, 370; Actinomyces krainski: Duché, Encyclopédie Mycologique, Paris, 6134, 306.) From Greek crythrus, red. Mycelium fine, branching; numerous open spirals formed as side branches of the main hyphse.

Gelatin stab: Abundant, dense, gray growth with pinkish tinge, chiefly on surface of liquefied medium.

Synthetic agar: Spreading growth with irregular margin, developing deep into the medium; color at first white, later turning yellowish, agar around growth has a white, milky surface. Aerial mycellum, thick, solid, white.

Starch agar: Cream-colored, circular colonies, with faint greenish tinge.

Glucose agar: Abundant, spreading, cream-colored growth, later turning brown chiefly on surface; center raised, lobate margin.

Plain agar: Cream-colored growth Glucose broth: Abundant, creamcolored surface growth.

Litmus milk: Yellowish surface zone; coagulated; peptonized, becoming alkaline.

Potato: Wrinkled, cream-colored growth, becoming yellowish.

rowth, becoming yellowish.

Nitrites produced from nitrates.

Soluble purple pigment formed.

Starch is hydrolyzed. Aerobic.

Optimum temperature 25°C.

Similar to Streptomyces erythrochromogenes (Species No 24) except that no brown soluble pigment is formed.

Source: From California and Hawaiian soils

Habitat : Soil.

Streptomyces cellulosae (Krainsky) comb. nor. (Actinomyces cellulosae Krainsky, Cent. f. Bakt, II Abt, 41, 1914, 662.)
 From M. L. cellulosa, cellulosa.

Conidia almost spherical, 13 microns in diameter, often arranged in chains Gelatin colonies: Circular, yellowish

Gelatın stab. Liquefied. Plain agar: White aerial mycelum. Ca-malate agar: Yellowish colonies; gray aerial mycelium. Soluble vellow nigment formed.

Glusses sear: Abundant growth grav normal mucalium Soluble vellow nutmant Starch agar : Same as on glucose agar.

Glucose broth Coarse flaky growth

Vellow pigment. Latmus milk · Peptonized.

Potato . Light gray growth gray serial myeelum. Natrates show slight reduction

Strong directation action. Executin is hydrolyzed.

Cellulose is decomposed.

Aerobic.

Ontimum temperature 30° to 35°C Habitat . Soil.

11. Streptomyces parvus (Krainsky) comb nov. (Actinomuces parvus Krainsky. Cent. f. Bakt., II Abt., 41, 1914, 662, Nocardia parra Chalmers and Christopherson, Ann Trop, Med, and Paraset 10, 1916, 268 ) From Latin parrus. emell.

Conidia more or less aval. 0.9 to 1.3 by 1.2 to 1.8 microns.

Gelatin: Colonies vellow. Slow lique-

faction Ca-malate agar. Small, vellow colonies with light vellow serial mycelium

Glucose agar: Same as on Ca-malate agur

Starch agar: Same as on Ca-malate acar.

Glucose broth: Hemispherical colonies in bottom of tube.

Litmus milk: Peptonized Nitrate slightly reduced. Moderate diastatic action.

Cellulose not decomposed. Aerobic.

Ontimum temperature.

Source Carden soil. Habitat · Soil,

12 Streptomyces malenconii (Duché) comb nov. (Actinomyces malencons Duche, Encyclopedie Mycologique, Paris, 6, 1931, 353.) Named for Mr. Malencon from whom the original culture was obtained

Gelatin. Poor growth: liquefaction.

Asparagine glucose agar : Rapid opaque growth, later becoming covered with white serial mycelium: amber-colored pigment, dissolved in medium

Pentone agar: Cream-colored lobous growth, covered with whitish serial mycolium

Asparagine glucose solution. Long. much beauching filaments, 0.5 to 0.7 micron, somewhat heavier agrial mycelum with a few irregular conidus - some flaky growth on bottom of tube surface growth is cream-colored with rare white aerial mycelium; liquid becomes slightly vellow.

Pentone solution. Whitish growth with vellowish soluble nigment

Milk. Surface growth with whitish aerial mycelium; slow pentonization. hand becoming brownish-colored.

Potato, Rand growth with thin white mycelium: no soluble pigment,

Coagulated serum. Radiating creamcolored growth covered with white aerial mycelium, slow liquefaction

No piement on tyrosine medium Source Culture obtained from Mr. Malencon, an inspector in Morocco.

13 Strentomyces diastaticus (Krunsky) comb. nov. (Actinomyces diastaticus Krainsky, Cent f. Bakt., II Bakt., 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 116.) From M. L. diastations, diastatic.

Actinomyces roseodiastaticus Duche. Encyclopédie Mycologique, Paris, 6, 1934, 329 is said to differ from both Krainsky's, and Waksman and Curtis' strains.

Filaments may show fine, long, narrow spirals. Conidia oval, 10 to 1.2 by 1.1 to 1.5 microns.

Gelatin stab. Liquefied with small. cream-colored flakes in liquid.

Synthetic agar: Thin, gray, spreading

growth. Aerial mycelium white, becoming drab grav. Starch agar. Thin, colorless, spreading

Glucose agar: Yellowish, spreading growth. No aerial mycelium. Plain agar: Cream-colored growth.

growth. Aerial mycelium gray.

Thin aerial mycelium. Glucose broth: Gray ring with gravish colonies in hottom of tube

Litmus milk: Brownish ring; coagulated : pentonized in 25 to 30 days, becoming faintly alkaline.

Potato: Abundant, wrinkled, creamcolored growth with greenish tinge. Nitrites produced from nitrates.

Brown to dark brown soluble nigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Habitat · Soil

14. Streptomyces fimicarius (Duché) comb. nov. (Actinomuces fimicarius Duché, Encyclopédie Mycologique, Paris. 6, 1934, 346 ) From Latin fimus, dung and carus, loving.

Gelatin: Punctiform colonies with whitish aerial mycelium; reddish soluble Liquefaction. pigment

Asnaragine agar, Cream-colored growth with whitish aerial mycelium; reverse side, cream-colored to slight othre.

Czanek's agar. Yellowish masses of growth with vellowish-white serial mycelium; reverse side orange-colored. faint vellowish soluble pigment

Pentone agar: Cream-colored growth with white aerial mycelium; reverse side. vellowish.

Asparagine solution. Vegetative filaments 0.5 to 0.6 micron long; branching aerial mycelium 0.8 to 1 0 micron, forming numerous conidia; flaky growth produced on bottom; surface growth becomes covered with a white aerial mycelium; reverse side, brownish-red.

Czapek's solution: Cream-colored

punctiform growth with vellowish serial mycelium: no soluble pigment.

Pentone solution : Whitish growth that flakes throughout liquid; vellowish pigment.

Tyrosine medium: White growth with vellowish reverse; yellowish soluble pigment

Milk: Colorless growth becoming covered with whitish aerial mycelium; slow pentonization of milk which becomes rosecolored, finally changing to brownish-red Potato: Cream-colored to vellowish

growth with whitish aerial mycelium; reddish-brown pigmentation of plug.

Coagulated serum: Cream-colored growth with whitish aerial mycelium: rapid liquefaction of serum.

Distinctive characters: Abundant growth upon neutral and acid media; whitish aerial mycelium: marked odor; soluble brownish-red pigment. This spe cies seems to form the transition type between the Actinomyces albus group and the Actinomyces chromogenus group.

Habitat . Found abundantly in manure.

15. Streptomyces flavovirens (Waksman) comb. nov. (Actinomyces 123, Waksman, Soil Science, 8, 1919, 117; Actinomyces flavovirens Waksman, in Manual, 1st ed., 1923, 352; Actinomyces albeviridis Duché, Frayclopédie Mycologique, Paris, 6, 1931, 317.) From Latin flavus, vellow and virens, becoming green

Large masses of minute tufts; the hyphae coarse, straight, short, relatively unbranched, beaded, open spirals may be produced in certain substances. Conidia spherical, oval to rod-shaped, 0 75 to 1.0 by 1.0 to 1 5 microns.

Gelatin stab Yellowish-green surface pellicle, consisting of a mass of small colonies, on the liquefied medium.

Synthetic agar : Growth spreading deep into the substratum, yellowish with greenish tinge. Aerial mycelium, gray, powdery.

Starch agar: Greenish-yellow, apreading growth, developing deep into the medium.

Glucose agar: Restricted growth, developing only to a very small extent into the medium, yellow, turning black, edge entire.

Plain agar. Yellowish growth; the reverse dark in center with yellowish zone and outer white zone.

Glucose broth: Thick, sulfur-yellow

pellicle or ring.

Latmus milk: Cream-colored to brown-

ish ring, coagulated; peptonized, becoming faintly alkaline.

Potato: Sulfur-yellow, wrinkled

growth
Only a trace of nitrite is formed from

nitrates.
Greenish-yellow soluble pigment

formed Starch is hydrolyzed.

Aerobic Optimum temperature 25°C Habitat Soil.

16 Streptomyces ollvochromogenus (Bergey et al ) comb. nov (Artinomyces chromogenus 205, Walsuma, Soil Science, 8, 1919, 106, Actinomyces olivochromogenus Bergey et al , Manuri, 2nd ed , 1925, 308) From Greek, producing an olive color

Filaments with numerous close spirals Conductoral or elliptical.

Gulatin stab Cream colored, spreading surface growth. Rapid liquefaction

Synthetic agar. White, apreading growth Aerial mycelium ash gray with brownish tingo.

bronnish tinge.
Starch agar Transparent, spreading growth

Glucose agar Abundant, natal brown to almost black growth, entire margin Plain agar Wrinkled, brown growth,

becoming gray-green Glucose breth Thin, brown growth,

Glucese breth Thin, brown growth

Litmus milk Dark brown ring; congulated; poptonized, becoming alkaline. Putato Small, wrinkled, black colonies.

Faint traces of nitrates formed from nitrates.

Soluble brown pigment formed, Starch is hydrolyzed, Aembic.

Optimum temperature 37°C. Habitat: Soil.

17. Streptomyces diastatochromogenes (Krainsky) comb. nov. (Actinomyces diastatochromogenes Krainsky, Cent f. Bakt, II Abt., 41, 1914, 682.)
From Greek, probably intended to mean producing both diastase and color.

Conidia apherical or oval, about 1.2 microns.

Gelatin colonies. Light gray-colored. Gelatin stab; Liquefied.

Plun agar: Medium sized colonies, with white to gray serial mycelium.

Ca-malate agar · Medium sized colonics, colorless, with gray aerial mycelium.

Glucose agar: Same as on Ca-malate

Starch agar · Same as on Ca-malate agar. Glucose broth · Flaky colonies in depth at first, later also over surface.

Potato Light gray colonics, gray serial myrchum, medium colored black. Soluble brown pigment formed in

gelatın Weakly diastatic.

No growth on cellulose, Tyrosinase formed.

Habitat . Soil.

Aerobic.

Ontimum temperature 35°C.

18 Streptomyces flavochromogenes (Krannsky) comb nos. (Artinomyces flavochromogenes Kraineky, Cent. f. Bakt, II Abt. 41, 1914, 662.) From Latin flavus, yellow and Greek, producing color

Conidia oval, 17 microns.

Gelatin colonies Yellowish colonies.

Gelatin stab: Slight fiquefaction.
Plan sgar: Acrial mycelium formed

late, at first white, later gray. Gray soluble pigment formed.

Ca-malate agar: Colonies yellow with white aerial mycelium forming late. Glucose agar: Brown soluble pigment formed.

Starch agar: Yellow colonies, with white aerial mycelium

Glucose broth: Fine flakes, with small spherical colonies adherent to glass. Medium colored brown.

Potato: Yellow colonies, with white aerial mycelium

Nitrites produced from nitrates.

Weakly diastatic. Esculin acted upon. Slow growth on cellulose

Tyrosinase formed.

Aerobic.

Optimum temperature 35°C Habitat: Soil

19 Streptomyces antibioticus (Waksman and Woodruff) comb. nov. (Actinomyces antibioticus Waksman and Woodruff, Jour Bact., 42, 1941, 232 and 246) From Greek, antibiotic.

Spore-bearing hyphae produced in the form of straight aerial hyphae. The conidiophores are arranged in clusters; no spirals formed. The conidia are nearly spherical to somewhat elliptical.

Gelatin: Dark brown growth on surface, with patches of gray aeral mycellium. Dark pigment produced, which gradually diffuses into the unliquefied part of the gelatin. Liquefaction at first very slow, later becoming rapid

Czapek's agar: Thin, whitish growth. Thin, gray aerial mycelium.

Peptone media. Production of dark pigment at early stage of growth is very characteristic. Growth brownish, thin, with a yellowish-gray to yellowish-green aerial mycelium

Potato plug: Folded, brown-colored growth, with a thin black ring on plug, fading into a bluish tinge No aerial mycelium

Carrot plug. Cream-colored to faint brownish growth. No aerial mycchum. No pigment.

Litmus milk Tinck, brownish ring on surface of milk Mouse-gray aerial mycelium with greenish tinge; growth becomes brown, especially in drier perious adhering to glass. No reaction charg, no coagulation of milk, no clearing, whi is he sediment at bottom of tube. Oldcultures: Heavy growth ring on surface of milk, heavy precipitation on bottom; he quid brownish to black in upper perion

Odor: Very characteristic soil odor.

Antagonistic properties: Has a marked antagonistic effect on Gram-positive and Gram-negative bacteria, much more on the former than on the latter, as well as actinomycetes. It is also active against fungi, which vary in degree of sensitivity Produces a specific bacteriostatic and bacterioidal substance known as actinomycin (Waksman and Woodruff, Jour. Bact., 40, 1940, 531).

Source: Isolated from soil on Escherchia coli-washed-agar plate, using living cells of E. coli as the only source of available nutrients.

Habitat: Soil.

20. Streptomyces viridochromogenst (Krainsky) comb. nov. (Actinomycestiidochromogenes Krainsky, Cent. 18kl, II Abt., 41, 1914, 682, Waksrun and Curtis, Soil Science, 1, 1916, 114) Prom Latin, green and Greek, producting color

Filaments with numerous open spirals, 3 to 5 microns in diameter, occurring as side branches and terminal condis, short ovals or spheres, 1 25 to 1.5 microns.

Gelatin stab: Cream-colored surface growth, becoming greenish. Slow liquefaction.

Synthetic agar: Spreading gronth, cream-colored with dark center, becoming dark green; reverse yellowish to light cadmium. Aerial mycelium abundant, spreading, white, becoming light green.

Starch agar: Circular, spreading, yel-

lawish colonies.
Glucose agar: Abundant, spreading, wrinkled, gray growth, becoming black

Plain agar: Abundant, restricted, gray growth, with greenish tinge.

Glucose broth: Dense, solid ring, brownish, becoming dark green.

Litmus milk: Dark brown surface growth, coagulated; peptonized, with faintly alkaline reaction

Potato · Ahundant, gray-brown growth Nitrites produced from nitrates Soluble brown pigment formed Starch is hydrolyzed

Starch is hydrolyzed

Aerobic

Optimum temperature 37°C. Habitat. Soil

 Streptomyces purpeochromogenus (Waksman and Curtis) comb nov. (Actinomyces purpeochromogenus Waksman and Curtis, Soil Science, 1, 1916, 113.)
 From Latin, purple and Greek, producing color.

Branching mycelium and hyphae with few imperfect spirals. Conidia spherical, 0.75 to 1.0 micron in diameter.

Gelatin stab. Slow, brownish surface growth Slow liquefaction

Synthetic agar: Slow, restricted, smooth, gray growth, becoming brown with purplish tinge; center raised Margin yellow.

Starchagar Small, dark brown colonies. Glucose agar. Abundant, restricted, gray growth, becoming brown to dark brown.

Plain agar · Gray to brownish growth, becoming dark brown, almost black.

Glucose broth: Shight, flaky sediment. Litmus milk Dark-browning; coegulated, slowly peptonized, with faintly alkaline reaction

Potato Restricted, orange to orangered growth.

Nitrites not produced from nitrates. Soluble dark brown pigment formed.

Starch shows slight hydrolysis. Acrobic.

Optimum temperature 25°C.

Source. Isolated once from California
adobe soil.

Habitat : Soil

22. Streptomyces phaeochromogenus (Conn) comb. nov (Actinomyces pheochromogenus (sic) Conn, N. Y. State Agr. Exp. Sta. Tech. Bull No 60, 1917, 16) From Greek, producing a brown color.

Branching filaments and hyphae, spirals narrow, open, elongated, smistrorse.

Gelatin stab: Abundant, spreading, cream-colored surface growth, becoming brown. Slow liquefaction.

Synthetic agar: Colorless growth, be coming brown to almost black. Aerial mycelium abundant, white with brownish shade.

Starch agar · Spreading, brownish growth, becoming brown.

Glucose agar: Restricted, much folded, brown growth

Plainagar: Thin, cream colored growth, becoming gray.

Glucose broth Dense, wrinkled

Litmus milk Dark, almost black ring; coagulated, with slow peptonization, fauntly alkaline reaction.

Potato Brown to almost black growth.

Nitrates produced from nitrates

Soluble brown pigment formed Starch is hydrolyzed Acrobic.

Optimum temperature 25°C Source Isolated from soil. Habitat Soil

23. Streptomyces aureus (Waksman and Cuttus) comb nov. (Actinomyces aureus Waksman and Cuttus, Soil Science, 1, 1916, 121; not Actinomyces aurea Ford, Textb. of Bact, 1927, 220) From Latin aureus, golden.

Mycehum shows numerous spirals. Conider spherical to oval, 0 5 to 1 0 by 0 8 to 1.4 microns.

Gelatin stab: Fair, cream-colored surface growth, becoming brown, spreading Liquefied.

Synthetic agar . Thin, spreading, color-

less growth. Aerial mycelium thin, gray, powdery, becoming cinnamon drab.

Starch agar: Thin, transparent, spreading growth.

Glucose agar: Spreading, light orange growth, raised center, hyaline margin.

Plain agar · Restricted, gray growth. Glucose broth: Thin, brownish ring; flaky sediment.

Litmus milk: Black ring. No coagulation. Peptonization doubtful.

Potato: Abundant, wrinkled, brown growth, becoming black.

Nitrites produced from nitrates. Soluble brown pigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Source: Isolated many times from a variety of soils.

Habitat : Soil.

24. Streptomyces erythrochromogenes (Krainsky) comb nov. (Actinomyces erythrochromogenes Krainsky, Cent f. Bakt., II Abt , 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 112.) From Greek, producing a red color. L. . n n miorone lape.

aluble

brown pigment formed.

Plain agar: Brown soluble pigment. White aerial mycelium.

Ca-mal. te agar Colonies circular, with grayish-white margined aerial mycellum. Glucose agar. Red pigment formed.

Starch agar . A soluble rose pigment on old cultures.

Glucose broth: Abundant growth. Floating colonics, later a pellicle is formed. Brown soluble pigment mycelium

acrial Potato: Gray Medium colored black

Nitrates show slight reduction. Weakly diastatic.

No proteolytic enzyme formed. No growth in cellulose.

Aerobic.

Optimum temperature 30°C.

Source: Soil and roots of Alnus (alder). Habitat : Soil.

25. Streptomyces lavendulae (Waksman and Curtis) comb. nov. (Actinomyces lavendulae Waksman and Curtis. Soil Science, 1, 1916, 126.) From M. L. lavender.

Hyphae coarse, branching. close, 5 to 8 microns in diameter. Conida oval, 1.0 to 12 by 16 to 20 merons Gelatin stab: Creamy to brownish surface growth. Liquefied.

Synthetic agar: Thin, spreading, colorless growth. Acrial mycelium cottony, white, becoming vinous-lavender.

Starch agar: Restricted, glistening, transparent growth.

Plain agar · Gray, wrinkled growth. Glucose broth: Abundant, flaky sediment.

Litmus milk: Cream-colored ring. No coagulation; peptonized, with strong alkaline reaction.

Potato: Thin, wrinkled, cream colored to yellowish growth.

Nitrites produced from nitrates. Soluble brown pigment formed. Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Certain strains of this organism produce antibiotics. One such antibiotic, designated as streptothricin, is active both in vitro and in vivo against various Gram-positive and Gram-negative bacteria, fungi and actinomycetes (Waksman and Woodruff, Proc. Soc. Exp. Biol Med., 40, 1942, 207; Waksman, Jour Bact., 46, 1943, 299).

Source · Isolated once from orchard soil Habitat: Soil.

26 Streptomyces reticuli (Waksman and Curtis) comb. nov. (Actinomyces reticuli Waksman and Curtis, Soil Science, 1, 1916, 118.) From Latin reticulum, a small net.

Mycelium in whorls; spirals formed on

glucose agar are sinistrorse. Conidia enhanical 10 to 14 microns in diameter

Colatin stab. Liquefied with small hown daken

Synthetic agar: Colorless growth, with vellowish tinge, becoming brownish. spreading Aerial mycelium thin white cottony.

Starch agar : Brownish-gray growth. Glucose agar: Restricted, hounish

grouth center raised Plain agar, Gray, wrinkled growth, be-

coming brownish Glucose broth Sediment consisting of

large colonies. Latmus milk · Reaction unchanged : co-

amiliated nentonized. Potato: Gray growth, with black

conter Natrites produced from nitrates

Dark brown niement formed Starch is hydrolyzed.

Acrobic

Ontimum temperature 25°C. Source From unland and adobe soils in California

Habitat · Soil

27 Streptomyces rubrireticuli nom nor (Actinomyces reticulus-ruber Waksman, Soil Science, 8, 1919, 146; Actinomuces reticulus Bergey et al . Manual. 2nd ed , 1925, 373 ) From Latin ruber. red and reticulum, a small net

Branching filaments with both primary and secondary whorl formation. Spirals formed on glucose agar. Conidia ovalshaped Gelatin stab: Surface growth vellow-

sh-red to dragon-pink. Liquefied Synthetic agar: Abundant, apreading

growth, usually pink Aerial mycelium thin, ruse to pink.

Starch agar White growth with red tipec

Glucose agar: Abundant, anreading, nose red, entire growth.

Plain agar Red growth, with yellowish margin, becoming red.

Glucore broth . Thin, flaky rediment

Litmus milk. Abundant red pellicle. cosmilated: pentonized Reaction unchannad

Poteto - Creem-colored growth leter nink to dock and

Nitrates produced from nitrates. Soluble dark brown pigment formed

Starch is hydrolyzed Aambie

Certain strains of this organism produos an antibiotic

Source: Isolated from New Jersey orchard and California unland soils. Ontimum temperature 37°C.

Habitat Soil

28 Streptomyces flavus (Kraipsky) comb nov (Actinomyces flavus Krainsky, Cent f Bakt . II Abt . 41, 1914, 662: Waksman and Curtis, Soil Science, 1. 1916. 118: not Actinomuces flarus Sanfelice, Cent. f Bakt., I Abt., Orig. 36. 1905 359 ) From Latin flains vellow

Coarse filaments with branching byphase Comdia formed by budding and

breaking up of hyphac into oval forms Gelstin steh Small, vellowish masses on surface of liquefied medium.

Synthetic agar . Circular, yellow or sulfur-yellow colonies Aerial mycelium straw-vellow.

Starch agar Spreading, eream-colored growth, with pink tinge.

Glucose agar Restricted, raised, folded, sulfur-vellow growth, center shading to hrow n

Plain agar Grav, spreading, folded eron th

Glucose broth Small, white colonies in

bottom of tube Litmus milk Congulated, peptonized,

becoming distinctly alkaline. Elevated, much wrinkled. Poteto greenish-olive growth

Traces of pitrate formed

Soluble brown pigment formed Statch is bydrolyzed

Acrobic

Optimum temperature 25°C. Habitat : Soil.

29. Streptomyces ruber (Krainsky) comb. nov. (Actinomyces ruber Kruinsky, Cent. f. Bakt., 11 Abt., 41, 1914, 662; Waksman, Soil Science, 8, 1919, 149; not Actinomyces ruber Sanfelice, Cent. f. Bakt., I Abt., Orig., \$6, 1904, 355; Nocardia krainskii Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268.) From Latin ruber, red

Straight, branching mycelium, radiating. A few spirals may be formed.

Gelatin stab . Liquefaction, with yellow flakes.

Synthetic agar: Abundant, spreading, red growth. Aerial mytelium abundant. cottony, chrome-orange.

Starch agar: Abundant, spreading, red growth.

Glucose agar: Restricted, abundant, entire, coral-red growth.

Plain agar: Restricted, elevated, wrinkled, olive-green growth.

Glucose broth: Red ring, with spongy colonies on the surface.

Litmus milk: Dark ring with red tinge; congulated; peptonized, with alkaline resction.

Potato: Elevated, wrinkled, greenish growth.

Natrites produced from nitrates. Soluble brown pigment formed. Starch is hydrolyzed.

Aerobie Optimum temperature 37°C.

Habitat : Soil.

30. Streptomyces citreus (Krainsky) comb. nov. (Actinomyces citreus Krainsky, Cent f. Bakt , 11 Abt , 41, 1914, 662; Waksman and Curtis, Soil Science, 1, 1916, 99; not Actinomyces citrcus Gasperini, Cent f. Bakt., 15, 1894, 684.) From M L citreus, lemon-yellow

Filaments with long, narrow open spirals. Conidia spherical to oval, 12 to 1.5 by 1.2 to 1 8 microns.

Gelatin stab : Yellowish, restricted surface growth. Liquefaction in 35 days.

Synthetic agar: Abundant, spreading, raised, wrinkled, citron-vellow growth. Aerial mycelium covering surface; citrosvellow.

Starch agar: Abundant, jellowishgreen growth.

Glucose agar: Extensive, glossy, oliveyellow, entire growth; center elevated. Plain agar: Restricted, cream-colored

growth. Glucose broth: Thin, wide, yellow ring;

flaky sediment. Litmus milk: Cream-colored surface

growth; congulated; pentonized, becoming alkaline Potato: Yellowish growth, aerisl my-

celium white. Trace of nitrite production from ni-

frate.

The pigment formed is not soluble. Starch hydrolyzed.

Acrobic.

Optimum temperature 37°C. Habitat : Soil.

31. Streptomyces fulvissimus (Jensen) comb. nov. (Actinomyces fulcissimus Jensen, Soil Science, 30, 1930, 66.) From Latin fulvissimus, very yellow.

Vegetative mycelium without any special characteristics aerial mycelium of short, straight, often trifurcated hyphae, 1.0 to 1.2 microns broad; no spiral formation; branches of hyphse break up into conidia, 1.0 to 1.2 by 1.2 to 1.5 microns.

Gelatin: Vegetative mycelium narrow, smooth, yellowish-brown to red-brown; no aerial mycelium; no pigment; gelatis completely liquefied in 10 to 12 days.

Nutrient agar : Good growth : vegetative mycelium raised, finely wrinkled, deep red-brown; no aerial mycelium; brownish.

yellow pigment.

Czapek's ugar: Good growth (one strain very scant), vegetative mycelium fat, narrow, first light golden, later deep orange to red-brown; aerial mycelium scant, sometimes almost absent, first white, later light grayish-brown; pigment very characteristic, bright golden to orange.

Glycerol agar: Good growth; vegetative mycelium narrow, raised, smooth, golden to dark bronze; aerial mycelium scant, in patches, white to light cinnamon-brown; pigment intensely golden to orange.

Starch-casein agar: Good growth; vegetative mycelium spreading, folded, yellowish-brown; aerial mycelium abundant, smooth, lead-gray; pigment dull yellow to orange.

Potato: Good growth; vegetative mycelium raised, much winkled, rustbrown; aerial mycelium absent or traces of white; pigment gray to faint lemonyellow.

Loeffler's blood serum: Vegetative mycelium red-brown; no aerial mycelium; vellowish pigment; no liquefaction.

Distinctive characters: The characteristic golden pigment is formed in nearly all medis in which the organism grows, but becomes most typical and attains its greatest brightness in synthetic agar media; it has indicator properties, turning red in strongly acid solutions. The species is easily recognized on agar plates by its bronze-colord colonies, surrounded by haloes of bright yellow pigment.

Source: Very common in Danish soils Habitat: Soil.

32 Streptomyces gougeroti (Duché) comb. nov. (Actinomyces gougeroti Duché, Encyclopédie Mycologique, Paris, 8, 1934, 272.) Named for Prof. Gougerot, from whom the culture was obtained.

Gelatin: Cream-colored colonies developing slowly with faint aerial mycelium; no pigment; liquefaction.

Plainagar: Cream-colored growth forming concentric ring with age, with brownish reverse; faint yellowish soluble pigment

Synthetic agar: Slow growth as punctiform colonies; cream colored with smooth edge; no serial mycelium; no soluble pigment.

Peptone broth: Cream-colored ring on surface of medium with flakes throughout the medium; no soluble pigment.

Synthetic solution: Submerged mycelium in the form of flakes, later forming a surface pellicle; filaments of aerial mycelium 1 micron in diameter, with numerous conidia; cream-colored growth; no soluble pugment

Tyrosine medium; Good growth with white aerial mycelium; no soluble pigment.

Litmus milk: Growth in the form of colonies which remain separated from one another; also flakes in the bottom of the tube with blush tinge on reverse of growth: milk turns blue in 10 to 12 days.

Coagulated serum: Cream-colored growth covered with white aerial mycelium: rapid liquefaction of serum.

Potato: Slow growth of a greenish tinge; aerial mycelium; no black pigment.

Distinctive character: Intermediate between Streptomyces albus with its abundant serial mycelium and Actinomyces almquisti with its very scanty aerial mycelium

Source Culture obtained from the collection of Prof. Gougerot.

33 Streptomyces violaceoniger (Waksman and Curtis) comb. nov (Actinomyces riolaceus-niger Waksman and Curtis, Soil Science, 1, 1916, 111) From Latin riolaceus, violet and niger, black.

Gelatin. Gray growth, with no production of aerial mycelium. Gelatin around colony rapidly liquefied, but without any change in color.

Cripek's agar Colony at first dark gray, turning almost black, 2 to 4 mm in dameter. Surface glossy, much folded with a very thin gray margin. A white to gray acral mycelum is produced after the colony leas well developed. A bluishblack pigment is produced at later stage of its growth. The pigment slonly dissolves in the medium, turning almost; black. Odor fairly strong. Microscopically two types of mycelium are found: the thin, branching flaments of the substratum, and the thick filaments of the aerial mycelium. The aerial mycelium fragments not very rapidly, producing a few conidia, spherical and oval, 1.2 to 1.5 by 1.2 to 2.3 microns. These often occur in chains.

Czapek's solution: Colonies large, 2 to 3 mm in diameter, appearing at the bottom and surface of the solution, but none throughout the medium. Colonies bluish in color, with a regular margin. Medium not colored

Potato plug: Growthat first very slight, but after 48 hours develops into a yellowish-gray continuous thick smear which later turns brown, with a white aerisl mycelium covering the growth. Medium not colored.

Source. Isolated once from the upland California soil

Habitat : Soil.

34. Streptomyces griseus (Krainsky) comb. nov. (Actinomyces griseus Krainsky, Cent. f Bakt, II Abt., 41, 1914, 662, Prom M L. griseus, grav.

Branching filaments; a few spirals have been observed. Conidia rod-shaped to short cylindrical, 0 8 by 0.8 to 1 7 microns. Aerial mycelium greenish-gray

Gelatin stab · Greenish-yellow or creamcolored surface growth with brownish tinge. Banid liquefaction

Synthetic agar Thin, colorless, spreading growth, becoming olive buff. Aerial mycelum thick, powdery, water-green Graph agar Thin spreading trans-

Starch agar Thin, spreading, transparent growth.

Glucose agar: Growth elevated in center, radiate, cream-colored to orange, erose margin

Plain agar · Abundant, cream-colored, almost transparent growth.

Glucose broth Abundant, yellowish pellicle with greenish tinge, much folded. Litmus milk. Cream-colored ring; coagulated with rapid peptonization, becoming alkaline.

Potato: Yellowish, wrinkled growth. Nitrites produced from nitrates. The pigment formed is not soluble.

Starch is hydrolyzed. Aerobic. Optimum temperature 37°C.

Different strains of this organism produce different antibiotics. One of these, streptamycin, was isolated in crystalize form. It is active against a large number of bacteria and actinomycetes, but not against fungi and viruses. It is not very toxic to animals, and has found extensive application in the treatment of various diseases, mostly caused by Gram-negative bacteria and certain forms of tuberculosis

Source: Garden soil. Habitat: Soil.

35. Streptomyces griseoflavus (Kninsky) comb. nov. (Actinomyces gristoflavus Krainsky, Cent. I. Bakt., II Abt., 41, 1914, 662.) From M. L. griseus, grand Latin flavus, vellow.

Conidia oval, 1 2 microns.

Gelatin colonies : Yellowish. Concentric

Gelatin stab: Rapidly liquebed.
Plain agar: Colonies yellowish, with
white aerial mycelium.

Ca-malate agar: Large colonies covered with yellow to greenish-gray aerial mycelium

Glucose agar . White aerial mycellum is slowly formed.

u.

celum gray.

Nitrites produced from nitrates,
Weakly diastatic. Acts on esculin.
Grows well on cellulose.
Aerobic
Optimum temperature 35°C.

Habitat . Scil

36. Streptomyces albidoffavus (Rossi Doria) comb. nov. (Streptotric (sic) albido-faca Rossi Dona, Ann. d. 1st. d'Ig. sper. d. Univ. di Roma, 1, 1891, 197; Actinomyces albido-farus Gasperini, ibid. 2, 1892, 222; Streptolhriz albido Chester, Man. Determ. Bact. 1901, 365; Cladothriz albido-fata Macé, Traité Pratique de Bact., 4th ed., 1901, 1907; Nocardia albida Chalmers and Christopherson, Ann. Trop. Med. and Parasit, 10, 1916, 271.) From Latin albidus, while and fatus, vellow.

Description from Duché, Encyclopédie Mycologique, Paris, 6, 1934, 294 Gelatin Punctiform colonies with white aerial mycelium on surface of liquid, no soluble pigment: rapid lique-

faction.

Synthetic asparagine agar; Growth becomes rapidly covered with white serial mycchum, later becoming whitishyellow; brown on reverse side; yellowish soluble pigment

Peptone agar: Cream-colored growth covered with fine white aerial mycelium, yellow soluble pigment.

Tyrosine agar. Fine growth with orange-yellow on reverse side, medium becomes colored yellowish to yellowish-

Synthetic asparagne solution: Long branching filaments, 0.6 micron in diameter Thicker aerial mycelium producing irregular spores; flaby growth dropping to bottom of tube Surface growth becomes covered with yelloushwhite aerial mycelium; brownish on reverse side, soluble pigment yellowish

Peptone solution Itapid, much folded growth, partly covered with white mycelium on surface of medium; soluble yellow-other pigment

Milk Rapid growth becoming covered with whitish serial mycelium, never fully covering the surface; no congulation, peptonization begins slowly and is completed in 13 days, Inquid becoming colored yellowish-orange Coagulated serum Cream-colored growth of surface becoming covered with white aerial mycelium; rapid liquelaction of serum.

Starch medium Cream-colored growth rapidly colored with yellow acrial mycelium; after 20 days growth becomes much folded; greenish on reverse side; slightly amber color in medium

This strain is closely related to Streptomyces albus. Develops poorly on Czapek's medium without asparagine. Source: From dust.

37. Streptomyces poolensis (Taubenhaus) comb nov. (Actinomyces poolensis Taubenhaus, Jour Agr. Res, 13, 1918, 416) Named for Prof. R. F. Poole, plant nathologist

Description from Waksman, Soil Sci , 8, 1919, 140

Fine, branching mycelium; spirals usually not seen. Conidia oval to elliptical

Gelatin stab Liquefied, with small, brownish flakes in fluid

Synthetic agar Thin, colorless, spreading growth Aerial mycelium white to gray

Starch agar. Restricted, cream-colored growth

Glucose agar. Growth abundant, light brown, glossy, raised center, entire.

Plain agar Yellowish, translucent growth.

Glucose broth. Thin, brownish ring. Litmus milk. Brownish ring: coagu-

Lited; peptonized, with strongly alkaline reaction

Potato Thin, reddish-brown; medium

becoming purplish.

Nitrites produced from nitrates.

Faint trace of soluble brown pigment.

Starch not hydrolyzed.

Optimum temperature 37°C.

Source Associated with disease of sweet potato.

38. Streptomyces olivaceus (Waksman) comb. nov. (Actinomyces 206. Waksman, Soil Science, 7, 1919, 117: Actinomyces olivaceus Waksman, in Manual, 1st ed., 1923, 354.) From Latin. olive-colored.

Small clumps, with straight and branching hyphae. No spirals on most media. Conidia spherical and oval. 0.9 to 1.1 by 0.9 to 20 microns.

Gelatin stab: Liquefied with creamcolored, flaky, yellow sediment.

Synthetic agar: Growth abundant, spreading, developing deep into medium. Yellow to olive other, reverse yellow to almost black. Aerial mycelium mousegray to light drab.

Starch agar: Thin, yellowish-green, spreading growth.

Glucose agar: Growth abundant, restricted, entire, center raised.

Plain agar: White, glistening growth. Glucose broth: Sulfur-vellow ring.

Litmus milk: Faint, pinkish growth; coagulated: peptonized, becoming alka-

Potato: Growth abundant, much wrinkled, clevated, gray, turning sulfurvellow on edge.

Nitrites produced from nitrates.

The pigment formed is not soluble. Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat : Soil.

(Duché) 39. Streptomyces lieskel comb. nov. (Actinomyces lieskei Duché, Encyclopédie Mycologique, Paris, 6, 1934, 289.) Named for Prof. Lieske of Leipzig.

Gelatin: Cream-colored growth becoming covered with white aerial mycesoluble pigment. Rapid lium: no liquefaction.

Plain agar: Cream-colored growth becoming covered with white aerial mycelium; yellowish soluble pigment.

Synthetic agar: Cream-colored growth with delayed white aerial mycelium growing from the edge toward the center; mycelium later yellowish. Reverse of growth yellowish to green. Dirty yellow to vellow-ereen soluble pigment.

Synthetic solution: Long branching filaments 0.7 micron in dismeter. Yellowish-white nerial mycelium does not readily produce spores; flakes drop to the bottom of the tube.

Pentone solution: Cream-colored colonies on surface with flakes in the liquid dropping to the bottom of the tube. Liquid becomes yellowish in color.

Tyrosine medium: Rapid growth on surface with whitish-vellow agrisl mucelium; yellowish to orange-vellow soluble pigment.

Milk: Cream-colored growth: colorless on reverse side: no aerial mycelum. Pentonization without coagulation. After 20 days the whole milk becomes a

clear vellowish liquid. Clear-colored Coagulated serum: growth. Rapid liquefaction.

Culture related to Streptomyces alboflavus and Streptomyces albidoflavus.

40. Streptomyces microflayus (Krainsky) comb. nov. (Actinomyces mitroflavus Krainsky, Cent. f. Bakt., H Abt, 41, 1914, 662; Micromonospora microfiata Encyclopédie Mycologique, Duché. Paris, 6, 1934, 29.) From Greek micrus, small, and Latin flavus, yellow.

Conidia large, spherical to rod-shaped, often in pairs or chains, 2.0 by 20 to 50 microns.

Gelatin colonies: Small, yellow Gelatin stab : Liquefied.

Plain agar: Yellow colonies, with roseyellow aerial mycelium in 3 to 4 weeks. Ca-malate agar: Minute yellow colo-

No aerial mycelium. Glucose agar: A rose-yellow aerial my-

celium develops in about 12 days. Starch agar: Same as on glucose ager

Glucose broth : Small spherical colonies in depth.

Litmus milk: Peptonized. Potato: Yellow growth. No aerial

mycelium Nitrites produced from nitrates. Strongly diastatic. Scant growth on cellulose. Starch is hydrolyzed.

Aerobic.

Ontimum temperature 25°C Habitat: Soil

41 Streptomyces cacaol (Waksman) comb. nov. (Actinomuces cacaoi Waksman, in Bunting, Ann. Appl. Biol., 19. 1932, 515.) Named for the chocolate tree (Theobroma cacao).

Long acrial mycelium with considerable spiral formation: the spirals are long and

open, not compact.

Gelatin Flocculent growth. No acrial mycelium. Rapid liquefaction. No pigment production.

Nutrient agar · Brown-colored growth covered with tiny patches of ivorycolored serial mycelium.

Glucose agar: Thin yellowish growth, later turning reddish-brown; no soluble niement: light gray to mouse-gray mycehum, with white edge. Typical odor of streptomyces.

Czanek's agar : Same as on glucose agar. Potato - Abundant brownish growth

with white to mouse-gray aerial mycelium. Biochemical characteristics: Strong

proteolytic entymes acting on casein and gelatin; strong diastatic action, no sugar or dextrin left in 1 per cent starch solution after a few days. Limited reduction of nitrate.

Source: Three strains isolated from cacao beans in Niceria. There were alight differences among the three strains; the above description is of Strain I.

42. Streptomyces novaecaesareae nom nor (Actinomyces riolaceus-caeseri Waksman and Curtis, Soil Science, 1, 1916, 111.) From Nora Caesarea, Latin name for the State of New Jersey.

Filaments with both straight and spiral aerial hyphae; spirals devtrorse. Conidia oval to clongate.

Gelatin stab : Small, cream-colored surface colonies with alow liquefaction.

Synthetic agar : Growth gray, becoming bluish, glossy, much wrinkled. Aerial mycelium appears late: white.

Starch agar: Restricted, circular, blueish-violet colonies.

Glucose agar ; Restricted, gray growth, becoming red.

Plain BUST: Thin, cream-colored pronth.

Glucose broth: Fine, colorless, flaky acdiment.

Litmus milk: Grav ring, coagulated: slow peptonization, becoming faintly alkaline

Potato: Gmath eream-colored.

wrinkled, turning yellowish. Nitrites produced from nitrates.

Soluble purple pigment formed, Starch is hydrolyzed.

Aerobic.

Ontinum temperature 37°C. Source · Isolated once from upland California soil.

Habitat · Soil

43. Streptomyces exfoliatus (Waksman and Curtis) comb. nov. (Actinomuces exfoliatus Waksman and Curtis. Soil Science, 1, 1916, 116 ) From Latin, strapped of foliage

Slightly wavy filaments with tendency to form spirals Conidia oval, 1.0 to 15 by 1.2 to 18 microns.

Gelatin stab. Cream-colored surface growth. Liquefied

Synthetic agar Growth colorless, becoming brown, smooth, glossy, Aerial mycelium in white patches over surface. Starch agar Restricted, gray growth, becoming brown.

Plain agar: Grows only in depth of medium.

Glucose broth, Small, gravish colonies in depth.

Litmus milk: Cream-colored ring, soft coagulum in 12 days; slow peptonization, becoming strongly alkaling.

Potato: Growth somewhat wrinkled, gray, becoming brown. Nitrates produced from natrates.

Brown, soluble pigment formed.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 37°C.

Source: Isolated several times from adobe and upland soils in California. Habitat: Soil.

44. Streptomyces gelaticus (Waksman) comb. nov. (Actinomyces 104, Waksman, Soil Science, 8, 1919, 165, Actinomyces gelaticus Waksman, in Manual, 1st ed., 1923, 356.) From M. L. gelaticus, gelatinous.

Branching mycelium with open spirals. Gelatin stab: Liquefied with creamcolored flaky sediment.

Synthetic agar: Growth colorless, spreading, chiefly deep into the medium. Aerial mycelium thin, white, turning grayish

Starch agar: Thin, spreading, creamcolored growth.

Glucose agar: Abundant, spreading, white growth

Plain agar: Wrinkled, cream-colored growth only on the surface.

Glucose broth Thin, cream-colored pellicle; slight flaky sediment.

Litmus milk Pinkish ring, coagulated; peptonized with distinctly alkaline reaction Potato: Growth abundant, much

wrinkled, greenish, becoming black wit's
yellowish margin
Nitrates show slight reduction to ii-

trites
Soluble brown pigment formed.

Soluble brown pigment Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Habitat · Soil

45. Streptomyces rutgersensis (Waksman and Curtis) comb. nov. (Achanamyces rutgersensis Waksman and Curtis, Soil Science, 1, 1916, 123.) Named its, Rutgers University, New Brunswick, New Jersey

Branching filaments with abundant open and closed spirals; hyphae fine, long, branching Conidia spherical and oval, 1.0 to 1.2 microns, with tendency to bipolar staining.

Gelatin stab: Cream-colored, spreading surface growth. Liquefied.

Synthetic agar: Growth thin, colorless, spreading, becoming brownish to almost black. Aerial mycelium thin, white, becoming dull-gray.

Starch agar: Gray, spreading growth. Glucose agar: Abundant, brown myclium, becoming black with cream-colored margin.

Plain agar: Thin, wrinkled, creamcolored growth.

Litmus milk: Cream-colored ring, coagulated; slow peptomization, becoming alkaline.

Potato: Abundant, white-gray, much folded growth.

Nitrites produced from nitrates. The pigment formed is not soluble. Starch is hydrolyzed. Aerobic.

Optimum temperature 37°C.

Source: Isolated many times from a variety of soils.

Habitat: Common in soil.

46. Streptizes Ilpmanii (varximand Curtis) comb. nor. (Actinomyca ilpmanii Waksman and Curtis, Sol Science, 1, 1916, 123.) Named for Prof. J. G. Lipman, New Jersey Agracultural Experiment Station.

Straight, branching mycelium and hyphae. Conidia oval, 0.8 to 1.1 by 10

to 15 microns.
Gelatin stab: Liquefied with cream-

colored, flaky sediment.

Synthetic agar: Growth abundant, ransed, colorless, becoming light bown and wrinkled. Aerial mycelium white, turning gray.

Starch agar: Transparent growth, be

coming dark with age.
Glucose agar: Light yellow, irregular,
spreading growth

Plain agar: Yellow, glossy, radiately

wrinkled growth.
Glucose broth: White ring, with sbundant, colorless flaky sediment Litmus milk: Cream-colored ring; coagulated, peptonization with alkaline re-

Potato: Abundant, cream-colored,

Nitrites produced from nitrates

The pigment formed is not soluble

Aerobic.

Optimum temperature 25°C.
Source Isolated many times from a

Habitat: Common in soil.

47 Streptomyces halstedii (Waksman and Curtis) comb. nov. (Actinomyces halstedii Waksman and Curtis, Soil Science, 1, 1916, 124) Named for a person

Branching mycelium and hyphae with close spirals Conidia oval or rodshaped, 1 0 to 1 2 by 1.2 to 1 8 microns

Gelatin stab. Liquefied, with small, cream-colored masses in bottom of tube. Synthetic agir. Growth abundant, heavy, spreading, raised, light, becoming dark, almost black Aerial mycehum white, turning dull-gray.

shite, turning dun-gray.
Starch agar Abundant, brownish,

glossy growth
Glucose agar Growth spreading, color-

less, wrinkled, center elevated, edge lichenoid, becoming brown.

Plain agar Restricted, wrinkled, cream-colored growth,

Glucose broth Small, colorless colonies in bottom of tube

Litmus milk. Cream-colored ring, coagulated, peptonized, becoming alkaline Potato Growth abundant, moist,

winkled, cream-colored with green tinge Nitrites produced from nitrates The pigment formed is not soluble.

Starch is hydrolyzed.

Optimum temperature 37°C Aerobic. Source: Isolated many times from the

deeper soil layers. Habitat: Common in subsoil.

48. Streptomyces hygroscopicus (Jen-

sen) comb. nov. (Actinomyces hygroscopicus Jensen, Proc. Linn. Soc New So. Wales, 56, 1931, 257.) From Greek, hygroscopic.

Hyphae of vegetative mycelium 0 6 to 0 8 muron in diameter. Aerial hyphae long, tangled, branched, 0 8 to 10 micron in diameter; aprials numerous, sinistrorse, narrow, usually short, only 1 or 2 turns, closed, typically situated as dense clusters on the main stems of the aerial hyphae Condia oval, 0 8 to 10 by 10 to 12 micross.

Gelatin: Slow liquefaction. No pig-

ment produced.

Nutrient agar: Good growth Vegetative mycelium raised, wrinkled, glossy, cream-colored; later yellowish-gray with yellowish-brown reverse. Occasionally a scant white aerial mycelium

Sucrose agar: Good to abundant growth. Vegetative mycelum heavy, superficially spreading, folded, glossy surface, white to cream-colored, later sulfur-yellow to yellowish-gray, with golden to light orange reverse. Soluble pigment of the same color Aerial myelum seant, thun, white or absent.

Glucose agar. Goed growth. Vegetative mycelum superficially aprading, surface granulated, cream-colored to straw-yellow, later dull chrome-yellow to brownish-orange. Aerial mycelum thin, smooth, dusty, white to pale yellowishgray, after 1 or 2 weeks more or less abunduntly interspersed with small, moist, dark violet-gray to brownish patches which gradually spread over the whole surface. Light yellow soluble nument

Potato Fair growth Vegetative mycelium raised, wrinkled, cream-colored, later yellowish gray to dull brownish. Aerial mycelium alsent or trace of white-

Milk Completely digested in 3 to 4 weeks at 30 °C without any previous coagulation. The reaction becomes faintly acid (nll 6.0 or less).

Nitrates not reduced with sucrose as source of energy

Sucrose is inverted.

Starch is hydrolyzed.

some strains

Distinctive character: In this species. the aerial mycelium (which in other actinomycetes is strikingly hydrophobic) on certain media (glucose or glycerol asparagine agar) becomes moistened and exhibits dark, glistening patches. These patches, when touched with a needle. prove to be a moist, smeary mass of spores. This characteristic feature is not equally distinct in all strains.

Cellulose is decomposed readily by

Source: Seven strains isolated from soils.

Habitat : Soil.

49. Streptomyces fradiae (Waksman and Curtis) comb. nov. (Actinomuces fradii Waksman and Curtis, Soil Science, 1, 1916, 125 ) From the name of a person.

Straight, branching filaments and byphae. No spirals. Conidia rod- or ovalshaped, 0.5 by 0.7 to 1.25 microns.

Gelatin stab: Cream-colored to brownish, dense growth on liquid medium.

Synthetic agar: Smooth, spreading, colorless growth. Aerial mycelium thick, cottony mass covering surface. sea-shell pink

Starch agar: Spreading, colorless growth.

Glucose agar: Growth restricted, glossy, buff-colored, lichenoid margin.

Plain agar Growth yellowish, becoming orange-yellow, restricted

Glucose broth: Dense, narrow, orangecolored ring; abundant, flaky, colorless sediment.

Litmus milk: Faint, cream-colored ring; coagulated; peptonized, becoming alkaline. Restricted. orange-colored

Poteto growth

Nitrites not produced from nitrates. The pigment formed is not soluble.

Starch is hydrolyzed.

Aerobic.

Optimum temperature 25°C.

Source: Isolated once from adobe soil in California

Habitat : Soil

50. Streptomyces alboflavus (Waksman and Curtis) comb. nov. (Actinomyces alboftavus Waksman and Curtis, Soil Science. 1. 1916, 120 ) From Latin albuwhite and flavus, vellow.

Straight, branching mycelium, with very little tendency to form spirals Very few eval-shaped conidia formed.

Gelatin stab: Abundant, colorless surface growth. Liquefaction occurs in 33 days.

Synthetic agar: Growth glossy, colorless, spreading, becoming yellowish Aerial mycelium white, pondery, with vellow tinge.

Starch agar: Thin, yellowish, spreading growth.

Glucose agar: Growth restricted,

much-folded, creamy with sulfur-yellow surface.

Plain agar: Restricted, cream-colored growth.

Glucose broth: White, cylindrical colonies on surface, later flaky mass in bottom of tube.

Litmus milk · Pinkish ring. No coagulation. Peptonized, becoming alkaline. Potato: Moist, cream colored, wrinkled

growih. Nitrites produced from nitrates.

The pigment formed is not soluble. Starch is hydrolyzed

Aerobic.

Optimum temperature 37°C.

Source : Isolated once from orchard soil Habitat : Soil.

51. Streptomyces albosporeus (Kralasky) comb. nov. (Actinomyces albosporeus Krainsky, Cent. f. Bakt, II Abt , 41, 1914, 649; Nocardía albosporea Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 263; Waksman and Curtis, Soil Science, 1, 1916, 99.) From Latin albus, white and Greek spora, spore.

Straight, branching filaments with straight, branching hyphae, and occasional spirals. Conidia spherical or oval, 0.8 to 1.2 by 1.0 to 1.8 microns.

Gelatin stab: Growth yellow, changing to red, with hyaline margin Lique-

faction in 35 days.

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Synthetic agar: Growth spreading, colorless with pink center, becoming brownish. Aerial mycelium white at first later covering the surface.

Starch agar: Growth thin, spreading, transparent, with red tinge.

Glucose agar: Growth spreading, red, wrinkled, radiate, entire.

Plain agar: Minute, ercam-colored

Glucose broth: Pinkish ring.

Litmus mulk; Scant, pink ring. No coagulation No peptonization. Potato: Growth thin, spreading, wrin-

Potato: Growth thin, spreading, wrinkled, gray, becoming brown with greenish tinge.

Nitrites produced from nitrates.

The pigment formed is not soluble. Starch is hydrolyzed. Accube.

Optimum temperature 37°C.
Habitat : Soil.

52. Streptomyces flocculus (Duché) comb nov. (Actinomyces flocculus Duché, Encyclopédie Mycologique, Paris, 6, 1934, 300.) From Latin, somewhat woully, referring to the appearance of the aerial mycelum.

Gelatin Very limited growth. Slow liquefaction

Asparagine glucose agar: Weak growth; limited cream-colored colonies hardly raised above the surface of the medium; occasionally abundant growth is produced with white seriid mycelium and colorless

Czapek's agur. Cream-colored growth, later covered with white aerial mycelium; no soluble nigment.

on reverse side.

Peptone agar Cream-colored growth, later covered with white aerial mycellium; no soluble pigment. Asparagine glucose solution: Branching immersed filaments, 0.8 micron in diameter; aerial mycelium 1.0 by 1.2 microns with numerous conidus; flakes settle to the bettom of the tube.

Peptone solution: Pointed colonies;

Tyrosine medium: Whitish growth

Milk Rose-colored growth; slow peptonization.

Potato: Punctiform growth covered with white aerial mycelium; faint yellow-

ish pigment.

Coagulated serum: Cream-colored growth; fine white aerial mycelium; slow lausefaction of serum

Source, Culture obtained from Mr. Malençon, an inspector in Morocco.

53 Streptomyces melanosporeus (Krainsky) comb. nov (Actinomyces melanosporeus Krainsky, Cent f. Bakt., II Abt., 41, 1914, 662; Nocardia melanospora Chalmers and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 268) From Greek melas, black and spora, spore

Conidia almost spherical, 12 microns in diameter.

Gelatin colony Small, reddish colo-

Gelatin stab. Liquefied.

Ca-malate agar Colonies red, with black aerial mycelium.

Glucose agar. Same as on Ca-malate agar.

Starch agar: Same as on Ca-malate agar.

Glucose broth Flaky, orange-red colonics adherent to glass

Litmus milk, l'eptonized.

Potato: Red colonies with black serial mycelium.

Nitrates produced from nitrates. Weakly distatic.

Grows well on cellulose. Cellulose is

decomposed Aerobic Optimum temperature 25°C. Habitat: Soil.

51. Streptomyces melanocyclus (Merher) comb. nov. (Micrococcus melanocyclus Merker, Cent. f Bakt., II Abt., St. 1911, 589; Actinomyces melanocyclus Krainsky, Cent f. Bakt., II Abt., 41, 1914, 662; Nocardia melanocycla Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268.) From Greek melas, black and cyclus, circle.

Conidia almost spherical, 0.9 micron in diameter.

Gelatin colonies: Growth poor.

Gelatin stab: Rapid liquefaction,

Ca-malate agar: Colonies small, flat, orange-red. Aerial mycelium black, occurring along the edges.

Glucose broth: Same as on Ca-malate agar.

Starch agar · Same as on Ca-malate agar. Glucose broth: Colorless, spherical colonies

Litmus milk: Pentonized. Nitrites produced from nitrates.

Good disstatic action. Cellulose is decomposed

Aerobic.

Optimum temperature 25°C. Habitat Soil

55 Streptomyces acidophilus (Jensen) comb. nov. (Actinomyces acidophilus Jensen, Soil Sci., 25, 1928, 226 ) From Greek, acid-loving.

Vegetative mycelium profusely branched, hyphae 06 to 0.8 micron in diameter with homogeneous protoplasm and no visible septa. Aerial mycelium with hyphae 10 to 1.2 microns in diameter, somewhat branched, forming either very few or very numerous sinistrorse spirals Oval conidia 1.0 to 1 2 by 1.2 to 1.5 microns.

Gelatin: After 10 days growth very scant, thin, colorless, semi-transparent Slow liquefaction.

Nutrient agar: No growth

Glucose agar: Good growth at 25°C Substratum mycelium raised, somewhat wrinkled, colorless in young culturer Aerial mycelium thin, white at first later gray or yellowish-brown.

Starch agar: Good growth at 25°C. Substratum mycelium flat, smooth, colorless. Aerial mycelium smooth, white.

Czapek's agar : No growth Plain broth: No growth,

Milk: No growth.

Potato: Growth good, raised, folded No discoloration.

Nitrites not produced from minus except a trace in two strains.

Diastatic. Weakly proteolytic.

Inversion of sucrose: Negative.

Distinctive character: The ability to live in acid media only. Source: Four strains isolated from

three acid humus soils. Habitat · Acid humus soils.

56. Streptomyces rubescens (Jarach) comb. nov. (Streptothriz rubescens Jarach, Boll. Sez Ital. Soc. Intern. Microb , 5, 1931, 43.) From Latin rubescens, becoming red.

Gelatin: No liquefaction; limited non pigmented growth.

Glucose agar: Large number of small round colonies raised in the center and growing together, as well as deep into the medium; of a whitish opalescent color.

Czapek's agar: Poor gronth, becoming pigmented salmon-red, edge entire. Milk agar medium; Rose-coral-colored,

thin growth with edge entire.

Broth: Minute flakes, the liquid later becoming reddish-colored Milk. No coagulation and no digestion,

slight red coloration of milk Potato plug: Reddish growth, not ex-

tensive; opalescent surface. Source: From soil.

57. Streptomyces thermophilus (Gilbert) comb. nor. (Actinomyces thermophilus Gilbert, Ztschr. f. Hyg., 47, 1904, 383; not Actinomyces thermophilus Berestnew, Inaug. Diss., Moskow, 1897; Nocardia thermophila Chalmers and Christopherson, Ann. Trop Med. and Parasit., 10, 1916, 271.) From Greek thermus, heat and philus, loying

Description from Waksman, Umbreit and Gordon, Soil Sci , 47, 1939, 49

Hyphae straight, conide formed

Gelatin · Liquefaction.

Czapek's agar: At 28°C, deep colorless growth, thin white aerial mycelium; no soluble pigment.

Starch agar: Yellowish growth with white-gray, powdery aerial mycelium.

Milk · Proteolysis.

Potato plug: Yellowish growth with no aerial mycelium, the plug usually being colored brown.

Starch is hydrolyzed

No pigment produced on nutrient agar or gelatin

Temperature relations. Optimum 50°C Good growth at 28°C. Usually no growth at 60°C. Some strains are incapable of growing at 28°C. whereas others

scem to grow well even at 65°C Aerobie

Habitat Soil, hay, composts

55 Streptomyces thermoluscus (Wahaman, Umbreit and Gordon) comb nor. (Actinomyces thermoluscus Wahsman, Umbreit and Gordon, Soil Sci, 47, 1939, 49) From Greek thermus, heat and Latin fuscus, dark Presumably derived to mean heat-loving and dark in color.

Hyphae spiral-shaped; conidia produced

Gelatin: Liquefaction At 50°C, a grayish ring is produced and soluble pigment is formed At 25°C, growth with no soluble pigment

Capek's agar. Poor growth at 25°C, deep gray, with but little aerisl mycelium. At 50°C, growth dark to violet, with gray to lavender aerial mycelium and soluble brown pigment.

Milk Proteolysis

Potato Abundant, dark-colored growth, no aerial mycellum, or few white patches, dark soluble pigment Starch is hydrolyzed.

Temperature relations: Good growth at 50° and 60°C. Will grow at 65°C. Faint growth at 28°C.

Aerobic.

Distinctive characters: This species is obstinguished from Streptomyces thermophilus by the brown-colored aerial mycelium on synthetic media, spiral-shaped hyphae, and ability to grow readily at 6250.

Habitat : Soils and composts.

59. Streptomyces scables (Thaxter) comb nov (Oospora scables Thaxter, Ann. Rept Conn. Agr Evp Sta., 1891, 153; Actinomyces scables Gussow, Science, N. S. 39, 1914, 431.) From Latin scables, scab.

Wavy or slightly curved mycelium, with long branched aerial hyphae, showing a few spirals. Conidia more or less eyhndrical, 0 8 to 10 by 1.2 to 15 microns

Gelatin stab. Cream-colored surface growth, becoming brown Slow liquefaction

Synthetic agar. Abundant, creamcolored, wrinkled, raised growth. Acrial mycelium white, scarce

Starchagar. Thin, transparent, spreading growth Glucose agar Restricted, folded,

Glucose agar Restricted, folder cream-colored, entire growth.

Plain agar: Circular, entire colonies, smooth, becoming raised, lichenoid, wrinkled, white to straw-colored, opalescent to opaque. Glucose broth: Ring in form of small

colonies, settling to the bottom

Litmus milk. Brown ring with greenish tinge; congulated; peptonized with alkaline reaction.

Potato: Gray, opalescent growth, becoming black, wrinkled

Nitrites produced from nitrates. Brown soluble pigment formed

Starch is hydrolyzed.

Optimum temperature 37°C.

Aerobic.

The potato scale organism, like other

acid-fast organisms, can be selectively impregnated with carbol-auromin and when exposed to ultraviolet radiation fluoresces bright yellow. This technic confirms Lutman's conclusion that the hyphae are intercellular and grow within the middle lamellae (Richards, Stain Tech., 18, 1943, 91-94).

Source: Isolated from potato scab lesions.

Habitat: Cause of potato scab; found in soil.

60. Streptomyces Ipomoea (Person and Martin) comb. nov. (Actinomyces ipomoca Person and Martin, Phytopath., 30, 1910, 313.) From M. L. Ipomoca, a ceneric name.

Conidia on glucose-casein agar: Oval to elliptical, 0.9 to 1.3 by 1.3 to 1.8 microns.
Gelatin: After 25 days at 20°C, scanty

growth, no aerial mycelium; no soluble pigment; liquefaction.

Synthetic agar: Abundant growth, mostly on surface of medium, moderately wrinkled, olive-yellow.

Nutrient agar: Moderate growth in the form of small, shiny, crinkled colonies both on the surface and imbedded in the medium, silver-colored.

Starch agar: Growth moderate, smooth, deep in medium, ivory-colored. Aerial mycelium white with patches of blushgreen. No soluble pigment Complete hydrolysis after 12 days.

Milk: Growth in form of ring; hydrolysis, without visible coagulation.

Potato: Growth moderate, light brown, shiny, wrinkled. No acrial mycelium. No soluble pigment.

Nitrites are produced from nitrates Starch is hydrolyzed.

No growth on cellulose.

Source: From diseased sweet-potato (Ipomoca sp ) tubers and small rootlets from several localities in Louisiana.

61. Streptomyces fordil (Erikson) comb. nov. (Actinomyces fordii Erikson, Med. Res. Counc. Spec. Rept. Ser. 203, 1935, 15 and 36.) Presumably named for the surgeon who first secured the culture.

Mycelium: Filaments of medium length, no spirals or markedly wavy branches. Short, straight, sparse aerial mycelium. Small oval conidia on potato agar and starch agar.

Gelatin: No visible growth, slight softening in 20 days; half-liquefied after 40 days.

U days.

Agar: Small, creamy-golden, ringshaped colonies, and heaped-up patches, becoming golden-brown in color and convoluted.

Glycerol agar: Extensive, goldenbrown, convoluted, thin layer.

Serum agar: Golden-brown ring shaped and coiled smooth colonies; no liquefaction.

Ca-agar: Yellow, scale-like closely adherent colonies; scattered white aerial mycelium.

Blood agar: Innumerable small yellowish ring-shaped colonies; no hemolysis.

Broth: Few flakes at first; later abundant coherent pufiball growth.

Synthetic sucrose solution: Moderate sediment of minute round white colonies. Synthetic glycerol solution: Light white fluffy colonies, minute and in clusters.

Inspissated serum: Innumerable colorless pinpoint colonies; scant white aerial mycelium; after 15 days colonies large, follow on reverse side; margin depressed; no liquefaction.

Dorsot's egg medium: Minute, creamcolored, elevated colonies, becoming golden-brown, raised, convoluted.

Milk: Coagulated; brownish surface

ing. Litmus milk: No change in reaction.

Potato plug: Yellowish growth in thin line, terminal portion tending to be piled up, scant white aerial mycelium at top of slant; after 12 days, growth abundant, golden-brown, confluent, partly honeycombed, partly piled up.

Starch not hydrolyzed.

Tyrosine sgar: Reaction negative. Source: Human spleen in a case of acholuric jaundice. 62. Streptomyces africanus (Puper and Pullinger) comb. nov. (Nocardia africana Pilper and Pullinger, Jour. Trop. Med. and Hyg., 30, 1927, 183, Actinomyces africanus Nannizzi, in Pollaci, Tratt. Micopat. Umana, 4, 1934, 8) From Latu Africanus. relatine to Africa

Description from Erikson, Med Res. Counc. Spec. Rept Ser. 203, 1935, 18

Unicellular branching mycelium forming small dense pink colonies with short straight sparse white aerial mycelium.

Gelatin, Irregular pink flakes; no

Agar A few flat pink discoid colonies Glucose agar: Minute red discrete round colonies and piled up paler pink pass with thus white agrad mycelum.

Glycerol agar: After 2 weeks, small heaped-up colorless masses with pink tinge around the colorless colonies, margin depressed, after 3 weeks, abundant, piled up, pale pink growth

Ca-agar After 1 week, small, round, colorless colonies with red centers, margins submerged; after 2 weeks, growth bright cherry-red, confluent, with color-less marcin.

Dorset's egg medium Small colorless blister colonies, partly confluent, becoming wrinkled, depressed into medium;

slight liquefaction
Serum sgar Irregularly round, raised,
wrinkled, colorless colonies, becoming
dry, pink and flaky; later piled up,
brownish, friable

Inspissated serum. After one week, smooth, round, colorless colonies with submerged margin, in confluent patches pink and pitted into medium; after 2 weeks, medium broken up, slight luque-faction; after 3 weeks, liquid dried up, colonies umbilicated, raised, dry and friable

Broth Small pink colonies embedded in coherent floculent mass

Synthetic sucrose solution Small pink granules in sediment after 1 week; colonies of medium size, coherent, after 3 weeks. Potato sgar: Bright red growth, small round colonies with colorless submerged margins, and piled up patches with stiff sparse white aerial mycelium.

Litmus milk: Bright red surface growth, liquid unchanged after one month; liquid opaque reddish-purple after 2 months, hydrolyzed, clear winered after 3 months.

Source: From a case of mycetoma of a foot in South Africa.

63. Streptomyces gallicus (Erikson) comb. nov. (Actinomyces gallicus Erikson, Mcd. Res. Counc. Spec. Rept. Ser. 203, 1935, 36.) From Latin gallicus, of the Gauls (French).

Description from Erikson (loc. cit., p. 24).

Mycelium shows lateral highly refractive bodies which appear almost identical with the singly situated stores found in

Micromonospura chalceae.

Gelatin. Scant irregular pink growth; liquefaction very slow, only slight degree in 20 days.

Agar: A few transparent minute pink, colonies; growth becomes partly confluent.

Clurose agar: No growth.

Glycerol agar. No growth, Czapek's agar. No growth,

Coon's agar: Minute colorless to pink-

Ca-agar Glossy pink pinhead colonies.
Potato agar. Pale pink, moist, granular
growth.

Serum agar: Pinpoint colonies, pink, shining.

Blood agar: Abundant growth, minute, discrete, round, pink colonies, some aggregated in confluent narrow bands. No hemolysis.

Dorset's egg medium Minute colonies, becoming confluent, tangerine-colored.

Inspissated serum. Abundant, pink, membranous growth, becoming reddirh-brown; later discrete colonies at margin.

clear on reverse side. No liquefaction Broth: Pinkish flakes.

Synthetic sucrees solution: A few fine white forcelli.

Synthetic glycerol solution: A few small round white colonies.

Milk Coagulated; peptonized; yellowish-pink surface ring.

Litmus milk: No coagulation or peptonization; no change in color.

Potato plug: Very slow growth, a few minute translucent pink colonies after 16 days; after 21 days, considerable increase in number of colonies, still small and discrete After 2 months, colonies 1 to 2 mm in diameter, bright coral, tending to be umblicated and heaped up. Tyrosine agar: Reaction nexative.

Source: From blood culture in a case of Banti's disease

64. Streptomyces pelletleri (Laveran) comb. nov. (Micrococcus pelletieri Laveran, Compt. rend Soe. Biol. Paris, 61, 1906, 340; Oospora pelletieri Thiroux and Pelletier, Bull Soc. path exot., 6, 1912, 585; Nocardia pelletieri Thiroux, see Pinoy, Bull Inst. Past, 11, 1913, 935; Discomyces pelletieri Brumpt, Précis de Parasitol., Paris, 2nd ed., 1913, 970; Actinomyces pelletieri Brumpt, ibid., 4th ed., 1927, 12041. Named for M. Pelletier who first isolated this species.

Pelletier who lirst isolated this species.

Description from Erikson, Med. Res.

Council Spec. Rept. Ser. 203, 1935, 21

Thiroux and Pelletier (Bull Soc. path. exot., 5, 1912, 585) considered that their cultures resembled Nocardia madurae, but they grew the organism only on Sabouraud's gelatin, on which it appeared in a constantly red, easily de-Nocardia indica was tachable form regarded as identical by Pinoy, although in the original description by Laveran the organism was called Micrococcus pelletiers, owing to the fact that no mycelium was seen, merely coccord bodies cardia genesii Froes (Bull Inst. Past., 29, 1931, 1153) is described as closely allied, the distinction being founded upon the fact that the red grains were smaller in size and much more numerous, but no cultural details are given.

Mycelium composed of slender straight and not very long filaments, forming small dense pink colonies with a few short straight isolated aerial branches.

Gelatin: Slight liquefaction; few pink flakes; later almost completely liquefied. Agar: Minute colorless colonies and

piled up pale pink masses.
Glucose agar: Poor growth, a few minute pink colonies.

Glycerolagar: Poor growth, a few moist : pink colonics.

Ca-agar: Colorless small colonies, after 1 week, confluent skin, pink, buckled; medium discolored later.

Coon's agar: Poor growth, creamcolored with pink center, mostly submerged.

Potato agar: Colorless blister colonies; after 3 weeks, colonies larger, showing concentric zones, submerged margins and occasional zone or tuft of white aerial mycelium, pinkish coloration

Dorset's egg medium: Abundaut, wrinkled, pink skin with small discrete colonies at margin in six days; later surface rough, mealy; considerable liquefaction in 17 days.

Serum agar: Moist cream-colored growth tending to be heaped up, discrete colonies at margin; becoming umbilicated.

Inspissated serum: Round, moist,

Blood agar: At first a few pinhead, cream-colored colonies, no hemolysis; later colonies dense, button-shaped, with narrow fringed margin.

Broth · Small, minute, pink, clustered colonies

Synthetic sucrose solution: Small, pink colonies in sediment; later minute colonies adhering to side of tube.

Milk: Soft curd; half-digested; peptonization complete in 20 days.

Litmus milk: Pink surface growth,

sporse, yellowish-pink, irregularly piled up, portions with scant white aerial mycelum; after 6 months abundant highly piled up small rounded pink masses, scant white aerial mycelium

Source: From a case of crimson-grained mycetoma in Nigeria (E. C. Smith, Trans R. Soc. Trop Med Hyg., 22, 1928, 157).

Habitat. Human infections so far as known.

65 Streptomyces listeri (Erikson) comb nov. (Actinomyces tisteri Erikson, Med Res. Council Spec. Rept. Ser 203, 1935, 36) Named for Dr Joseph Lister, the father of antiseptic surgery

Description from Erikson (loc cit,

p. 23).

Long slender filaments, many loosely wavy, forming a dense spreading mycelium which rapidly grows into a membrane on most media. Aerial mycelium very slow and inconstant in appearance, short and straight, conida oval

Gelatin. Slight liquefaction; round white surface colonies; after 45 days, confluent skin, almost completely liqueford.

Agar. Smooth, round, moist, creamcolored, margin depressed, center elevated, closely adherent; becoming umbilicated, with a myceloid margin

Glucose agar: Cream-colored, glistening, pinpoint colonies; later aggregated in convoluted skin.

Glycerol agar. Abundant, moist, cream-colored growth, colonies elevated, piled up; powdery white aerial mycelium. After 20 days, skin deeply buckled; colorless with exuded drops.

Ca-agar: Poor growth, a slight biscuntcolored membrane
Potato agar: After one week, extensive

growth, colorless submerged colonies, warted surface; durty pink coloration after 2 weeks; scant white aerial mycelium after 4 months.

Dorset's egg medium. No growth

Blood ager: Small, round, creamcolored colonies, smooth translucent surface; no hemolysis.

Serum agar: Small, irregular, moust, erram-colored colonies, tending to be

heaped up; later somewhat transparent. Inspissated serum Abundant growth, colorless shiny colonies, centrally elevated becoming confuent

Broth: Small, round, white colonies in

Glucose broth Small, white, nodular

Synthetic sucrose solution: Delicate white colonies in suspension and in sediment.

Litmus milk: Coagulation. No change

Potato plug: Abundant, dull, brownish, wrinkled skin with white acrial mycelium; large, stellate, fluffy, white colonies in hund at base.

Source: From human material Strain from Lister Collection

Habitat From human infections so far

66. Streptomyces upcottil (Litikon) comb nor. (A new pathogenic form of Streptothraz, Gibson, Jour Bact and Path, £3, 1920, 337, Actinomyces upcottin Erikson, Med Res Council Spec. Rept. Ser 203, 1935, 36) Named for Dr. Harold Upcott, the surgeon who first secured the culture

Description from Erikson (loc. cit.,

p 22)
Filaments characteristically long, strught, much interwoven and ramified, typical uncellular mycelium, usually forming medium to large heavy cartilaginous colonics. Gilson states that the threads vary in the knorces and above septa, but this has not been confirmed. A very slight transient aerial mycelium appeared on one sgar slope, but this has not been repeated on any slide inferiently of the state

along streak, round cream-colored colonies on surface Partly liquefied in 14 days; complete liquefaction in 2 months

Agar: Smooth, shining, round, creamcolored colonies, margin submerged, scant white aerial mycelium in one week; colonies large (up to 10 mm in diameter), centers elevated, greenish tinge, very sparse aerial mycelium in two weeks; the aerial mycelium disappears and large radial grooves appear in most colonies in 3 weeks.

Glucose agar: Smooth, round, creamcolored colonies, margin depressed, centers elevated, hollow on reverse side; later a coherent membranous growth, . piled un, vellowish.

Glycerol agar: Small, round, creamcolored, glistening colonies, heavy texture, margins submerged; later, colonies umbilicated, tending to be piled up; after 6 weeks, growth very much convoluted and raised, broad submerged margin, slightly reddish medium.

Coon's agar: Small, radiating, white colonies, growth mostly submerged.

Ca agar: Small, colorless membranous growth with undulating margin; later, centrally depressed into medium.

Potato agar: Poor growth, small, colorless blister colonics, medium slightly discolored.

Dorset's egg medium: Round, flat, colorless, scale-like colonies, some marked by concentric rings and slightly hollowed in center; growth becomes yellow-brown.

Serum agar: Large colonies (3 to 4 mm in diameter), colorless, granular, centrally elevated, depressed at margin, resembling limpets.

Blood agar Large drab heavily textured colonies; no aerial mycelium; no hemolysis.

Broth: Large coherent mass composed of fluffy colonies.

Synthetic sucrose solution: Fair growth, minute white colonies.

Carrot plug: Colorless, spreading, moist, wrinkled growth in six weeks; later a dull greenish-brown, moist, very much wrinkled and depressed skin.

Source. From the spleen in a case of acholuric jaundice.

Habitat: From human infections so far as known.

67. Streptomyces hortonensis (Erikson, comb. nov. (Actinomyces horton Erikson, Med. Res. Council Spec. Rept. Scr. 203, 1935, 36.) Named for the Horton War Hespital at Epsom, England from which the culture was obtained.

Description from Erikson (loc. cit., p. 22).

Typical germination into very slow growing unicellular mycelium composed of long slender straight branching filaments. Very sparse straight aerial mycellium produced only once on potato. Non-acid-fast.

Gelatin: Round cream-colored colonies on surface and a few mm below. No liquefaction.

Agar: Very slow growth, a few smooth cream-colored coiled colonies in 19 days; after 2 months, liberal, irregular, convoluted growth.

Glucose agar: Coiled and heaped up cream-colored translucent masses; after 2 months, growth rounded, elevated, ridged outwards from hollow center.

Glycerol agar: Coiled, colorless, lustrous patches, isolated colony with central depression.

Serum agar: Poor growth, small amorphous cream-colored mass.

Inspissated serum: Intricately coiled cream-colored growth. No liquefaction.

Broth: Flakes.

Synthetic sucrose solution: Poor growth, a few flakes.

Synthetic glycerol solution: Delicate white florculi at lesse.

Litmus milk: Green surface growth, liquid hydrolyzed, partly clear purple; later decolorized, brown.

Potato agar: Colorless blister colonies in one week; dull green heaped and coiled mass after 3 weeks; medium becomes slightly discolored.

Potato ping: After 3 weeks, abundant, coloriess, umbilicated, round colonier, some coiled in raised masses; later, liberal olive-green growth, piled up, dense, velvety gray-green aerial mycelium at top of slant, small round fluffy white colonies in liquid at base.

Source: From pus-containing typical actinomycotic granules from parotid -1-10000

Habitat - From human infections so for an known

68. Streptomyces gibsonii (Erikson) comb non (Actinomuces arbsons Erikson Med Res Council Spec. Rent Ser. 203, 1935, 36 ) Named for Prof. Gibson of Oxford

Description from Erikson (loc. eit... n 15)

Young growing mycelium branches profusely at short intervals; later grows out into long frequently wavy filaments: twisted hyphae also seen on water sear. Power of producing serial mycelium emparently lost.

Colutin: Dull white flakes sunking as medium liquefies; liquefaction complete

in 12 days.

Agar Small, cream-colored, depressed. partly confluent colonies, becoming an extensive wrinkled cream-colored skin

Glucose agar: Cream-colored wrinkled membranous growth.

Potato agar Wrinkled glistening membranous growth.

Serum agar · Small moist cream-colored colonies growing into medium.

Dorset's eeg medium Small, round. amouth, colorless colonies with conscally elevated centers.

Inanisated serum : Innumerable colorless pinnoint colonies with scant white acreal mycellum at top; after 8 days, a coherent wrinkled skin with brownishred discoloration at reverse, medium becoming transparent; completely liquefied, pigmented brown in 15 days Blood agar Yellowish confluent bands,

pregularly wrinkled, with small discrete colonies, clear hemolytic zone.

Broth Sediment of flocculi, some round and (an shaped colonies.

Synthetic sucrose solution: Very delicate a bite flocculi.

Potato plug: No growth.

Starch not hydrolyzed.

Milk · Congulated; pertly peptonized.

Tymsine ager. Nogstive reaction

Source: From the solven in a case of scholuric isundica Injected into a monkey and reisolated

Hebitet. From human infections so for sa known

69. Strentomyces beddardii (Crekson) comb nov. (Actinomucia beddardii Ecik. son Med Res Council Spec Rant Sor 203, 1935, 36.) Presumably named for the surgeon who first secured the culture.

Description from Erikson (loc cut n. 13).

Rapidly growing, dense, spreading mycelium composed of very long slander filaments, many wavy or closely coiled particularly on chicase sear spirale loca marked or lacking on pooter nutritive media like synthetic glycerol acar or water agar Acrial mycelium sparse short, straight on synthetic glycerol agar, much slower and more plentiful on glucose agar; later shows long, very fine spirals breaking up into small oval conidus; acrial hyphae straighter and more branched with shorter condonhores on

Gelatin: Dull white flakes sinking to bottom as medium lunuclies; houefaction complete in 8 days

starch seer Non seid fast.

Acar: Colorless, coherent, wrinkled, membranous growth with submerged margin; after 3 months, medium discolored, scant white acrual mycelium at top

Glucose sgar: Wrinkled membranous growth; after 2 months, scant white serial mycelium.

Glycerol agar: Small, cream-colored. discrete colonies becoming confluent. under surface much buckled.

Potato agar . Moist, cream-colored skin. convoluted, closely adherent.

Ca-ager: Extensive, moist, creamcolored, wrinkled, membranous growth.

Coon's ager: Frant, cream-colored. membranous growth.

Starch agar: Spreading, colorless growth, considerable white serial my-

Blood agar: Hemolysis. Growth in uniformly striated colorless bands, occasional round colonies at margin, Dorset's egg medium: Extensive, very

wrinkled, membranous growth, surface bright yellow. After 2 months, considerable liquefaction. Serum agar: Wrinkled, glistening,

eream-colored, membranous growth.

Inspissated serum. Colorless smeary growth, reverse becoming transparent, starting to liquefy at base; completely liquefied and brown in 12 days.

Suspended and sedimented colorless flocculi, some small round colonies.

Synthetic sucrose solution; Abundant white colonies in coherent mass near bottom of tube; large shell-shaped masses

Synthetic glycerol solution: At first, a few round white colonies in suspension: later, large branched feathery mass at bottom

Milk: Coagulated, later peptonized. Litmus milk. Medium deep blue, be-

coming hydrolyzed to clear purple. Potato plug. Colorless moist membranous growth with scant white aerial my-

celium at top of plug Starch is hydrolyzed.

Tyrosine agar Reaction negative

Source. Human spleen in a case of spleenic anemia

Habitat From human infections so far as known

70. Streptomyces kimberi (Erikson) comb. nov. (Actinomyces kimberi Erikson, Med Res Council Spec Rept. Ser. 203, 1935, 36 ) Presumably named for the surgeon who first secured the culture. Description from Erikson (loc. cit.

p 14). Mycelium of long straight profusely

branching filaments forming circumscribed colonies on all media with abundant production of short straight and branched aerial mycelium, small round Non-ac W-fast conidia

Gelatin Liquefied Smooth shining

colonies becoming powdery white with aerial mycelium, floating on liquefied medium. No pigmentation.

Agar: Smooth round moist creamcolored colonies, 1 mm in diameter; after 17 days, white powdery aerial mycelium. Glucose agar: Discrete cream-colored colonies becoming confluent, white aerial mycelium.

Glycerol agar: Moist cream-colored colonies becoming confluent, white aerial mycelium.

Potato agar: Extensive growth covered by white powdery aerial mycelium: large colorless exuded droplets. Wort agar: Heavy brownish lichenoid

colony; after 30 days, a white serial mycelium.

Ca-agar: Dull cream-colored scaly growth, covered by chalky white serial mycelium.

Coon's agar: Extensive growth, white aerial mycelium in annular arrangement

Czapek's agar: Small colonies covered with white aerial mycelium.

Blood agar · Many large colonies, creamcolored, tough, smooth, glistening, with margin depressed; no hemolysis.

Serum agar; Moist, cream-colored honeycombed skin, seant white serial mycelium.

Dorset's egg medium : Closely adherent scale-like colonies, centrally elevated, with white aerial mycelium.

Inspissated serum: Rapid spreading growth, discrete round colonies at margin, completely covered with white aerus mycelium, colorless transpired drops; slight softening at base.

Broth: Small round colonies in sediment in 2 days; supernatant colonies with white aerial mycelium and large hollow flakes in sediment in 15 days; occasional reddish-brown coloration.

Synthetic sucrose solution: Round white colonies at bottom; later small stellate colonies in suspension and a few supernatant with white aerial mycelium.

Synthetic glycerol solution: Hound white colonies at bottom; later coherent mulberry-like mass composed of fluffy round portions; after 15 days, irregular wispy flocculi and large coherent mass.

Milk: Coagulation; no peptonization; initial pinkish-brown ring descends until medium is dark brown throughout (2 months).

Litmus milk: Blue coloration, hydrolyzed to clear purple in 2 months.

Starch not hydrolyzed.

Tyrosine agar. Reaction negative. Source Blood culture of a woman with acholuric jaundice.

Habitat. From human infections so far as known.

71 Streptomyces somallensis (Brumpt) comb nov (Indiella somaliensis Brumpt, Arch Parasis, Paris, 10, 1900, 489, Discomyces somaliensis Brumpt, Précis de Parusstologie, Paris, 2nd ed, 1913, 907, Indiellopsis somaliensis Brumpt, told Nocardia somaliensis Brumpt, told Nocardia somaliensis Chalmers and Christopherson, Ann. Trop. Med and Parasit, 10, 1916, 239; Streptothrax omaliensis Muescher, Arch Derm Syph Ilis, 124, 1917, 297; Actinomyces somaliensis St. John-Brooks, Med Res. Council Syst of Bact, London, 8, 1931, 75). Named for the country of origin, French Somaliand.

Description from Lrikson (Med Res. Council Spec. Rept. Ser. 203, 1935, 17).

Simple branching unicellular mycelium with long straight filaments, forming circumseribed colony crowned with short straight aerial mycelium

Gelatin Cream-colored colonies, medium pitted; complete liquefaction in 10 days, hard black mass at bottom

Agar. Abundant yellowish granular growth with small discrete colonies at margin, later growth colorless, colonies umbilicated

Glucose agar: Poor growth, moist cream-colored elevated patch

Glycerol ager. Abundant growth, minute round to large convoluted and piled up masses, colorless to dark gray and black

Ca-agar: Round cream-colored colonies, depressed, umbilicated, piled up, thin white aerial mycelium; colonies become pale brown

Potato agar: Small round colorless colonies, zonate margin depressed, confluent portion dark greenish-black.

Blood agar: Small dark brown colonies, round and umbilicated, piled up confluent bands, reverse red-black; hemolysis.

Dorset's egg medium: Extensive colorless growth, partly discrete; becoming opaque, cream-colored, very wrinkled; later rough, yellow, mealy, portion liquid. Serum agar: Spreading yellow-brown

skin, intricately convoluted
Inspissated serum Cream-colored

coiled colonies, medium pitted, transparent and slightly liquid

Broth: A few round white colonies at

Broth: A lew round white colonies at surface, numerous fluffy masses in sediment, later large irregular mass breaking into wisps.

Synthetic sucrose solution: Minute round white fluffy colonies in sediment; after 17 days, scant wispy growth

Milk: Soft semi-liquid congulum which undergoes digestion; heavy wrinkled surface pellicle, completely liquefied in 12 days

Litmus milk Soft coagulum, partly digested, blue surface ring; clear liquid in 12 days

Potato plug Abundant growth, colonies round and oval, partly piled up in rosettes, frosted with whitishering aerial mycelum, plug discolored, after 16 days, aerial mycelum transient, growth nearly black.

Although Streptomyces somolicens has been known for a long time, there has been until recently no detailed descriptions of the organism beyond the fact that it prosesses a detained hard bard around the grain which is involuble in potash and cau de javelle. The rare occurrence of repta and occasional intercality chlamydospiris is reported by Brumpt (Arch. Parsait, 19, 1935, 527), but has not been confirmed by Erikson (Get ett.) Chalmersand Christople from (Am. Trop Med Parsiit, 10, 1916, 223).

merely mentioned the growth on potato as yellowish-white and lichenoid without describing any aerial mycelium. Balfour in 1911 reported a case but gave no data, and Fülleborn limited his description to the grain (Arch. Schiffs. Trop. Hys., 15, 1911, 131). This species was first placed in Indiella, a genus of fungi, by Brumpt (1906, loc. cit.). Later Brumpt (1913, loc. cit.) proposed a new genus or subgenus, Indiellopsis, containing the single species Indiellopsis sombliensis.

Source: Yellow-grained mycetoma, Khartoum (Balfour, 4th Rept. Wellcome Trop. Res. Lab., A. Med., London, 1911, 365).

Habitat: This condition has been observed by Bauflord in French Somaliland, by Balfour (loc. cit.) in the Anglo-Egyptian Sudan, by Fulleborn (loc. cit.) in German So. West Africa and by Chalmers and Christopherson (loc. cit.) in the Sudan.

72. Streptomyces panjae (Erikson) comb. nos. (Actinomyces punja Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 36.) Named for Dr. Panja who first secured the culture.

Description from Erikson (loc. cit.,

Unicellular mycelium with slender branching filaments; very small round colonies; no aerial mycelium visible on any medium, but occasional isolated aerial branches Non-acid-fast.

Gelatin: Complete liquefaction in 4 days.

Agar: Colorless irregularly piled up convoluted growth; after 1 month, easily detachable, brownish.

Glucose agar: Small colorless coiled mass in 1 week, heaped up green growth

in 2 weeks.

Glycerol agar: Poor growth, scant

colorless patch.

Ca-agar: Colorless to pink apreading growth with minute discrete colonies at margin; after 2 weeks, bright red mass,

buckled and shining, colorless submerged margin.

Coon's agar: Small submerged colorless growth.

Potato agar: Small elevated convoluted colorless masses with purple tinge in center.

Dorset's egg medium: Small round tough colorless colonies, margin well embedded; after 3 weeks, colonies elevated, warted, darkened, medium discolored and broken; slight degree of liquefaction, medium dark brown.

Serum agar: Colorless, glistening, piled up, convoluted mass.

Inspissated scrum: Small round blister colonies and irregularly convoluted patches deeply sunk in pitted medium; after 2 weeks, medium transparent, slight degree of liquefaction.

Broth: Flakes and minute colorless colonies.

Glucose broth: Poor growth, scant flakes, pinkish.

Synthetic sucrose solution: Pinkish flocculi; after 3 weeks, moderate growth, minute colorless colonies.

Milk: Coagulation; pale green surface growth; mostly digested in 2 weeks. Litmus milk: Soft coagulum, color un-

Litmus milk: Soft coagulum, color unchanged; after 2 months, mostly digested, residue coagulum light purple.

Source: From an ulcer of the abdominal wall. Calcutta.

73. Streptomyces willmoret (Eriksan) comb. nov. (Actinomyces willmoret Erikson, Med. Res. Council Spec. Rept. Ser. 203, 1935, 36.) Named for Dr. Willmore who isolated the culture.

Description from Erikson (loc. cit.,

p. 19).
Germination usual, but growing unicellular mycelium frequently branches
at very short intervals, presenting peculiar clubbed and budding forms with
occasional separate round swolen cells
which may represent the cystics of other
writers. The filaments are characteristically long, borogeneous, and much
interwoven. Aerial mycelium is profuse

in most media, with a marked tendency to produce loose spirals (water and synthetic elycerol agar) with chains of ellineoidal conida Thick serial clusters may also be formed

Gelatin: Minute colorless colonies: banefaction

Agar Heavy folded colorless lichenoid growth, rounded elevations covered with s hite serial mycelium · later submerged margin round confluent growth serial mycolum merked in concentric conce

Glucose agar: Colorless wrinkled confluent growth with smooth entire margin. large discrete colonies like fist resettes: after 4 months, scant white serial mycolum

Glycerol agar · Round smooth erramcolored colonies, heavy texture, margin submerged stiff sparse serial spikes. after 3 weeks, colonics large (up to 10 mm in diameter).

Ca-agar. Spreading colorless growth. nitting medium, submerged undulating margin: very scant white serial mycolum

Coon's agar · Oraque white growth extending arregularly (up to 3 mm) into medium, margin smooth and submerged. center raised, preenish tinge covered with white aerial mycelium; after 3 weeks, margin green, central mass covered by gray serial mycelium.

Potato agar. Fair growth, partly submerced, covered with grayish-white acrial mycelium, medium becomes discolored.

Blood agar Heavily textured small desh colonies, serial mycelium microsconical: no hemolysis.

Dorset's egg medium. Large, round. colorless, scale-like colonies, radially wrinkled; growth brownish, medium descolored in 2 weeks.

Serum agar: Smooth colorless discoid colonies; marked umbilication after 2 weeks.

Broth : Large fluffy white hemispherical colonies, loosely coherent.

Synthetic sucrose solution: A few large round white colonies with smooth partly ronate margina lightly coherent in sediment: later smaller colonies in suspension attached to side of tube

Milk: Congulation: one-third nontonized

Carrot plug. Colorless reised colonice with powdery white serial mycelium; after 1 month, very much piled up, serial mycelium gray: after 2 months superabundant growth around back of pluc confluent, greatly buckled, all-over gray aerial mycelium.

Source: Strentothricosis of liver (Willmore, Trans. Roy Soc. Trop. Med. Hyr ... 17, 1924, 344).

Habitat : From human infections so for as known

\*Appendix: The following names have been used for species of Streptomuces. Many of them are regarded as new by their authors merely because they were isolated from a new type of lesion, or from some animal other than man. Others are inadequately described species from air, soil or water. Relationships to other better described species are usually very obscure. Some of the species listed here may belong in the appendix to the genus Nocardia.

Actinomyces aerugineus Wollenneber (Arb d. Forschungsinst, f. Kartoffellen. 1920, 16 ) From deep scab on potato. Actinomyces albidofuscus Neukirch.

(Actinomuces albido fuscus Berestnew Inaug. Diss., Moskow, 1897; see Cent. f. Bakt., I Abt., 24, 1899, 707; Neukirch. Inaug. Diss, Strassburg, 1902, 3.) From grain. Actinomyces albidus Duché, (Enev-

elopédie Mycologique, Paris, 6, 1931.

Actinomyces alboatrus Waksman and

This appendix was originally prepared by Prof. S. A. Waksman and Prof. A. T. Henrici, May, 1913; it has been developed further by Mrs Eleanore Heist Clise, Geneva, New York, August, 1945.

Curtis. (Soil Science, 1, 1916, 117.) From adche soil.

Actinomyces alboviridis Duché. (Encyclopédie Mycologique, Paris, 6, 1934, 317.)

Actinomyces albus (Rossi Doria) Gasperini. (Streptotrux (sic) alba Rossi Doria, Ann. d. 1st. d'Ig. sper. d. Univ. di Roma, f. 1891, 421; Streptothrix Nos. 2 and 3. Almquist, Ztschr. f. Hyg., 8, 1890, 189, Oospera doriae Sauvageau and Radais, Ann Inst. Past., 6, 1892, 251; Actinomyces boois albus Gasperini, Actinomyces boois albus Gasperini, Attinomyces Lorent. P. V., 9, 1894; Gasperini, Cent. f. Bakt., 16, 1894, 685.) A general name applied to the most common streptomyces in air and water.

Actinomyces albus asporagenes Berestnew. (Inaug. Diss., Moskow, 1897; see Cent. f. Bakt., I Abt., 24, 1898, 708)

Actinomyces albus var. ochraleucus Wollenweber (Arb. d. Forschungsinst. fur Kartoffelbau, 1920, 16.)

Actinomyces albus - vulgaris Ciani (Quoted from Baldacci, Boll. Sez Ital. Soc. Internaz. di Microbiol, 9, 1937, 140.)

Actinomyces almquisti Duché (Duché, Encyclopédie Mycologique, Paris, 6, 1934, 778.) From culture laheled Actinomyces albus (Krainsky) Waksman and Curtis (Soil Sci. 1, 1916, 117; said to resemble Streptolhriz No. 1, Almquist, Zischr. f. Hyg., 8, 1890, 189).

Almquist, Zischr. f. Hyg., 8, 1890, 189).
Actinomyces alm Peklo (Cent. f. Bakt., 11 Abt., 27, 1910, 451) From swellings of the roots of Alnus glutinosa

Actinopyces annulatus Wollenweber.
(Arb Forschungsinst, für Kartoffelbau, 1920, 16) From dark-colored potato stem.

Actinomyces (Streptothrix) annulatus Beigerinek (Folia Microbiologica, 1. 1912, 4.)

Actinomyces aurea (dn Bois Saint Sévérn) Ford (Streptothriz aurea du Bois Sant Sévérn, Arch de méd. nav , 1895, 252; Nocardia aurea Castellani and Chalmers, Man Trop. Med., 2nd ed., 1913, 518, Oospora aurea Sartory, Champ. Paras. Homme et Anim , 1923, 818; Ford, Texth. of Bact., 1927, 220; not Actinomyces aureus Waksman and Curtis, Soil Science, 1, 1916, 124) Possibly synonymous with Actinomyces aureus Lachner-Sandoval, Die Strahlenpilze, 1893, according to Lieske, Morphol. u. Biol. d. Strahlenpilze, Leipzig, 1921, 26. Found in conjunctivitis.

Actinomyces bellisari Dodge. (Streptolhriz alba Bellisari, Ann. Ig. Sperim, 14, 1904, 467; Oospora alba Sartory, Champ. Paras. Homme et Anim, 1923, 819; Dodge, Medical Mycology, St. Louis, 1935, 744.) Isolated in a warehouse in Naples from the dust of cercal coming from California.

Actinomyces bovis var. nigerianus Erikson. (Med. Res. Council Spec. Rept. Ser. 203, 1935, 20 and 36.) From streptothricosis of the skin of cattle in Nigeria.

Actinomyces candidus (Petruschky)
Bergey et al. (Streptothriz candidus
(Gedanenis II) Petruschky, Verhandl.
d. Kongr. f. innore Med., 1895; see
Petruschky, in Kolle and Wassermann,
Handb d. path Mikroorg, 2 Aufl, 6,
1913, 285 and 294; Nocardia candidu
Castellani and Chalmers, Man. Trep.
Med., 2nd ed., 1913, 818; Discomyces
candidus Brumpt, Précis de Parasitof,
Paris, 2nd ed., 1923, 980; Bergey et al.,
Manual, 1st ed., 1923, 347.) From hu-

man lung.

Actinomyces carneus (Rossi Doria)
Gasporini. (Streptolrix carnea Rossi
Doria, Ann. 1st. d'Ig. sper. Univ. Roma,
1, 1891, 415; Gasperini, ibid., 2, 1892,
222; Oespora carnea Leimann and Neumann, Bakt. Diag., 1 Aufl., 2, 1892,
388; Cladothrix carnea Maré, Traité
Pratique de Bact., 4th ed., 1991, 1996;
Discomyces carneus Brumpt, Précis de
Parasitol., 2nd ed., 1913, 976; Neardia
carnea Castellani and Chalmers, Man.
Trop Med., 2nd ed., 1913, 818.) From
sir.

Actinomyces carnosus Millard and Burr (Ann. Appl. Biol., 15, 1926, 601.) From scab on potato.

Actinomyces casei Bernstein and Morton (Jour. Bact., 27, 1931, 625.) Thermophilic. From pasteurized cheese. Actinomyces coti (Rivolta) Gasperini. (Discomyces coti Rivolta, 1878; Gasperini, Cent. f. Bakt., 15, 1894, 684) Cause of a discase in a cot.

Actnomyces cerebriformis Namyslowski. (Namyslowski, Cent. f. Bakt., I Abt., Orig., 62, 1912, 564; Streptothruz cerebriformus Chalmers and Christopherson, Ann. Trop. Med. and Parasst., 10, 1916, 273, Nocardia cerebriformus Vuillemin, Encyclopédie Mycologique, Paras, 2, 1931, 126) From an infection of the cornea of the human eve.

Actinomyces cereus. (Quoted from Lieske, Morphol. u. Biol d Strahlenpilze, Leipzig, 1921, 33)

Actinomyces chromogenus (Gasperini) Gasperini (Streptotriz nigra Doris, Ann d. Ist d'Ig sner, d Univ di Roma 1, 1891, 419: Strenigtrix eromagena (sic) Gasperini, according to Rossi Doria, idem, Gasperini, ibid . 2. 1892. 222. Cosnora chromogenes Lehmann and Neumann. Bakt Diag . 1 Aufl . 2, 1896, 389, Cladotherz chromogenes Macé. Traité Pratique de Bact , 4th ed . 1901, 1075. Actinomuces niger Brumpt, Précis de Parasitol . Paris. 4th ed . 1927, 1206 ) A general name for streptomyces from air producing a dark chromogenesis on protein media

cinereonineraromaticus Actinomyces Neukirch (Actinomuces einereus niger aromaticus Berestnew, Inaug. Diss., Moskow, 1897; see Cent f. Bakt . I Abt . 24. 1898, 707; Neukirch, Inaug. Diss , Strassburg, 1902, 3, Nocardia cinereomara Chalmers and Christopherson. Ann Trop Med and Parasit . 10. 1916. 271. Streptothrix einereonigra gromatica, attributed to Berestney by Chalmers and Christopherson, idem; Actinomyces concrea-macr. quoted from Lieske, Morphol u Biol d Strableppilze, Leipzig, 1921, 33 ) From grain-

Actinomyres citreus Gasperni (Gasperin, Cent. f. Bakt, 15, 1894, 684, Streptalbris citrea Kruse, in Flügge, Die Mikroofganismen, 2 Aufl. 2, 1896, 63, not Actinomyres citreus Krainsk), Cent f. Bakt., II Abt., 41, 1914, 692) Actinomyces clavifer Millard and Burr. (Ann. Appl. Biol., 13, 1926, 601.) From

Actinomyces coroniformis Millard and Burr. (Ann Appl Biol , 18, 1926, 601.) From past soil

Actinomyces craterifer Millard and Burr. (Ann. Appl Biol., 13, 1926, 601.)

Actinomyces cloacae Brussoff. (Cent. f. Bakt., 11 Abt., 49, 1919, 97) From mud.
Actinomyces cretaceus (Kruger) Wollenweber. (Oospera cretacea Krüger, Berichte der Versuchsstat. f. Zuckerrohrs, Kergok-Legal, 1809; Wollenweber, Arbetten d. Porschunessnäthut für Kar-

toffelbau, 1920, 16) From potato scab.
Actinomyces dicksom: Erikson. (Med
Res Council Spec. Rept Ser. 203, 1935,
17.)

Actinomyces elastica Söhngen and Fol. (Cent. f. Bakt., II Abt., 40, 1914, 92.)

From garden earth

Actinomyces ferrugeneus Naumann.

(Kungl Svenska Vetenskapsakad.

Handt, I, 62, Part 4, 1921, 45) From

Aneboda region of Sweden. Deposits

ferrie hydroxide about the mycelial

threads.

Actinomyces filiformis (Bora) Nannizi. (Bacillus filiformis Bosa, 1897, not Bacillus filiformis Tils, Zischr f Hyg, 9, 1899, 291, not Bacillus filiformis Migula, Syst. d Blakt, 2, 1909, 387, Nocardia filiformis Vullemin, Encyclopédic Mycologique, Paris, 2, 1931, 132; Nannizzi, in Pollacci, Tratt Micopat. Umana, 4, 1934, 29) From the human stomach.

Actinomyces fimbriatus Millard and Burr. (Ann Appl Biol , 15, 1926, 601.) From scab on potato

Actinomyces floregriesus Duche, (Encyclopédie Mycologique, Paris, 6, 1931, 341.) From volenne soils (Martinique), Actinomyces flarus Sanfelice, Csanfelice, Cent. f. Bakt., I. Abt., Orig, 39, 1901, 329, Strepholáriz flara Sanfelice, ibid.; not Streph thriz flara Chester, Manual Determ. Bact., 1901, 362; not Actinomyces flarus Krainsky, Cent. f. Bakt., II Abt , 41, 1914, 662.) From air.

Actinomyces flavus Millard and Burr. (Millard and Burr, Ann. Appl. Biol., 15, 1926, 601; not Actinomyces flavus Sanfelice, Cent f. Bakt., I Abt., Orig., 55, 1904, 359; not Actinomyces flavus Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662; not Actinomyces flavus Dodge, Medical Mycology, St. Louis, 1235, 752.) From scab on podato.

Actinomyces foersteri (Cohn) Gasperini. (Streptothrix foersteri Cohn. Beitr. z. Biol. d. Pflanz., 1, Heft 3, 1875. 186: Cladothrix foersteri Winter, Die Pilze, in Rabenhorst's Kryptogamen-Flora, I Abt., 1, 1884, 60; Nocardia foersteri Trevisan, I generi e le specie delle Batteriacee, 1889, 9; Oospora foersteri Sauvageau and Radais, Ann. Inst. Past , 6, 1892, 252; Gasperini, Cent. f. Bakt., 15, 1894, 684: Discomuces foersteri Gedoelst, Les champignons parasites de l'homme et des animaux domestiques. Brussels, 1902, 176; Cohnistreptothrix foersteri Pinoy, Bull. Inst. Pasteur, Paris, 11, 1913, 937 ) The first streptomyces to be described. Probably not identifiable. From an inflamed tear duct. Chalmers and Christopherson (Ann Trop. Med. and Parasit., 10, 1916, 273) include Leptothrix oculorum Sorokin, 1881 as a synonym of this species. Actinomyces fusca Sohngen and Fol. (Cent. f. Bakt , II Abt., 40, 1914, 87.) From garden earth.

Actinomyces gabritschewsky, Neukirch. (Actinomyces of Gabritschewsky, Berestnew, Inaug. Diss., Moskow, 1897; see Cent. f Bakt., I Abt., 24, 1898, 708; Neukirch, Inaug. Diss., Strassburg, 1902, 3.) From water.

Actinomyces gedanensis (Löhlein) Bergey et al. (Streptothrix gedanensis J. Scheele and Petruschky, Verhandl. d. Kongr f. innere Med., 1897, 550; Streptothrix gedanensis Löhlein, Ztschr f. Hyg. 65, 1900, 11; Nocardis gedanensis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 255; Discomyces gedanensis Brumpt, Précis de

Parasitol., Paris, 3rd ed., 1922, 984; Bergey et al., Manual, 1st ed., 1923, 347.) From sputum of patient with chronic lung disease.

Actinomyces gibsoni Dodge. (Streptothriz sp. Gibson, Jour. Path. Baet, 23, 1920, 357; Oospora sp. Sattory, Champ. Paras. Homme et Anim., 1923, 776; Dodge, Medical Mycology, St. Louis, 1935, 722.) See page 961.

Actinomyces gracilis Millard and Burr. (Ann. Appl. Biol., 18, 1926, 601.) From

scab on potato.

Actinomyces graminearum Berestnew.
(Berestnew, Inaug. Diss., Moskow, 1837;
see Cent. f. Bakt., I Abt., 24, 1893, 707;
Nocardia graminarium (sic) Chalmers
and Christopherson, Ann. Trop. Med.
and Parasit., 10, 1916, 285; Streptokriz.
graminarium Chalmers and Christopher-

son, idem.) From grain.

Actinomyces graminis Topley and
Wilson. (Aktinomyces, Bostroem,
Beitr. path. Anat u. Path, 9, 1891, 1;
Topley and Wilson, Princip. Bact. and
Immun., 1st ed., 1, 1931, 250; Actinomyces bostroemi Baldacci, Boll. Sez.
Ital Soc. Internat. Microbiol., 9, 1937,

141.) From bovine actinonycosis.

Actinomyces gruberi Terni. (Terni,
Cent. f. Bakt., 16, 1894, 362; Nocardia
gruberi Blanchard, in Bouchard, Traité
Path. Gén., £, 1896, 855; Streptelhriz
grueberi (sic) Sanfelice, Cent. f. Bakt.,
I Abt., Orig., 56, 1901, 356; Osspora
gruberi, quoted from Nannizzi, Tratt.
Micopat. Umana, 4, 1934, 51.) From
soil. Produces several pigments on

culture media.

Actinomyces guignardi (Sauvagesu aud
Rudsis) Ford. (Oospora guignardi Sauvagesu and Rudsis, Ann. Inat. Past., 6,
1832, 285; Ford, Textb. of Dact., 1927,
220) From dust. Gasperini (loc. cit.)
regards this as a poesible synonym of
Actinomyces chromogenus.

Actinomyces halotrichis ZoBell and Upham. (Bull. Scripps Inst. Oceanography Univ. California, 6, 1914, 273) From marine mud and kelp.

Actinomyces heimi Duché. (Encyclo-

pédie Mycologique, Paris, 6, 1934, 359.) Actinomyces hoffmanni (Gruber) Gas-

Actinomyces adjunanti (Grucer) Gasperini. (Micromyces bolnanni (sic) Gruber, Münch. med. Wochnschr., 1891; also Arch. f. 1892, 252, 35; Oospora hoffmanni Sauvageau and Radais, Ann. Inst. Past., 6, 1892, 252; Gasperini, Cent. f. Bakt., 15, 1894, 63; Streptothriz hofmanni Kruse, in Flügge, Die Mikroorganismen, 3 Aufl., 2, 1896, 62; Cladothriz hoffmanni Macé, Traité Pratique de Bact, 4th ed., 1901, 1081.) Pathogenic. See pase 976

Actinomyces holmesi (Gedoelst) Nannizzi. (Discomyces holmesi Gedoelst, Champ. Paras. Homme et Anim, 1902, Nannizzi, Tratt. Micopat. Umana, 4, 1934, 49)

Actinomyces hominis Waksman. (Soil Science, 8, 1919, 129) Culture received from K. Meyer from Foulerton who isolated it in 1911 from an abscess of the palm. Waksman (loc. cit.) and Baldacci (Mycopathologia, 2, 1910, 160) regard this as identical with Bostroem's organism (see Actinomyces grammis above) and Baldacci has renamed it Actinomyces innominatus.

Actinomyces incanescens Wollenweber. (Arb. Forschungsinst. für Kartoffelbau, 1920, 16.) From the soil of potato fields near Berlin

Actinomyces intermedius (Krüger) Wollenweber. (Oospora intermedia Krüger, Berichte der Versuchsstat. 1. Zuckerrohrs, Kergek-Legal, 1890, Wollenweber, Arb. d Forschungsinst. für Kartofichau, 1920, 16.) From the soil of potato fields near Berlin.

Actinomyces interproximalis (Fennel) Ford. (Streptothrix interproximalis Fennel, Jour. Inf Dis., 22, 1918, 567; Ford, Textb of Baet, 1927, 195) From the mouth.

Actinomyrea invulnerabilia (Acosta and Grande Rossi) Lachner-Sandoval (Cladothriz invulnerabilia Acosta and Grande Rossi, Cronica medicoquirurgica de la Ilabana, No. 3, 1893; sec Cent. I Bakt, 14, 1893, 14; Streptothriz invulnerabilia Kruse, in Flügge, Die Mikroorganismen, 3 Aufl, 2, 1895, 64; Lachner-Sandoval, Ueber Strahlenpilze, Strassburg, 1895; Nocardia invulnerabilis Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 271.) From river water.

Actinomyces krausei (Chester) Ford. (Streptothris aus Eiter, Krause, Münch. med. Wchuschr., 40, 1899, 749 and Cent. I. Bakt., I Abt., 46, 1899, 209; also see Petruschky, in Kolle and Wassermann, 2 Aufl., 6, 1913, 267; Streptothriz krausei Chester, Manual Determ. Bact., 1901, 364; Nocardia krausei Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 263; Discomyces krauses Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 993; Ford, Tevtb. of Bact., 1927, 208.) From actinomy-cotic pus.

Actinomyces lacertae Terni. (Terni, LOBiciale Sanitario, 1806, 160; Streptothriz lacertae Foulerton, in Allbutt and Rolleston, Syst. of Med., 2, 1912, 200; Oospora lacertae Sartory, Champ. Paras. Homme et Anim., 1923, quoted from Nannizzi, Tratt. Micopat. Umana, 4, 1934, 51.) From grayish nodules in the liver of Italian leards (Lacerta viridis and L. agilis).

Actinomyces lathridii (Petruschky)
Ford. (Streptothrix lathridii Petruschky, Verhandl. d. Kong. f inner
Med., 1898, Ford, loc cit, 205.) From
the beetle, Lathridius rugicollis.

Actinomyces loidensis Millard and Burr. (Ann. Appl. Biol., 15, 1926, 601.) From seab on potato

Actinomyces Inter-restus Sanfelice. (Actinomyces borns Interoseus Gasperini, Cent. f Bakt., 15, 1894, 681; Sanfelice, Cent. f. Bakt., I Abt., Orig., 56, 1901, 335.) Isolated from actinomycotic lesion in cutile

Actinomyces marginalus Millard and Burr. (Ann Appl. Biol., 15, 1926, 601.) From scab on potato.

Actinomyces marinolimosus ZoBell and

Upham. (Bull. Scripps Inst. Oceanography Univ. California, 5, 1911, 256.) From marine mud.

Actinomyces melanoroscus Roisia. (Wisti Nauk Doslid, Kat. biol. Odessa, 1, 1929, 60.)

Actinomyces metchnikori (Sauvageau and Radas) Furd. (Oospora metchnikori Sauvageau and Radais, Ann. Inst. Past., 6, 1812, 212; Ford, Inc. cit., 220.) From water. Gasperini (Inc. cit.) regreds this organism as a possible synonym of Actinomyces chromogenus.

Actinomyces muris ratti Licake. (Streptothrex ratti Schottmüller, Dermat. Wochnschr., 58, 1911, Supplement, 77; Strentothrix muris-ratti Dick and Tunnicliff, Jour Inf. Dis , 25, 1918, 186; Licske, Morphol. u. Biol. d. Strahlenpilze, Leipzig. 1921. 31; regarded as identical with Streptobacillus montliformis Levaditi, Nicolau and Poinclour, Compt. rend. Acad Sci. Paris, 180, 1925, 1188 by Topley and Wilson, Princip, of Bact, and Immun., 2nd ed., 1936, 271. The latter organism is regarded as identical with Haverhillia multiformis Parker and Hudson, Amer. Jour. Path., 2, 1926, 357 by Van Rooyen, Jour. Path. and Bact., 45, 1936, 469; Actinomyces muris Topley and Wilson, loc, cit ) From a case of rat-bite fever.

Actinomyces musculorum Hertwig. (Actinomyces musculorum suis Duneker, Etschr I. Microskopieu Fleischheschau, 5, 1884, No. 3, Hertwig, Arch. f. wissensch. n. prakt Thierbeilk., 12, 1893, 365; Ouspora musculorum suis Lehmann and Neumann, Itakt. Diag., 1 Aul., 2, 1896, 383) Seen in calcareous deposits in the muscles of swine.

Actinomyces myricae Peklo. (Cent. f. Bakt., II Abt., 27, 1910, 451.) From the roots of Myrica.

Actinomyces from Neddeni, Namysłomski. (Cent f. Bakt, I Abt., Orig., 62, 1912, 65t.) From the human cyclid. Actinomyces nigricans Killian and Fehér. (Ann Inst. Past., 55, 1935, 620.) From desert soil.

Actinomyces nigrificans (Krüger) Wol-

lenweber. (Oospora nigrificans Krüger, Berichte der Versuchsstat. f. Zuckerrohrs, Kergok-Legal, 1890; Wollenweber, Arb. Forschungsinst. für Kartoffelbau,

1920, 16.) From potato scab.

Actinomyces nitrogenes Sartory, Sartory, Meyer and Walter. (Bull. Acad. Méd., Paris, 116, 1936, 186; also Ann. Inst. Past., 58, 1937, 681.) From sputum.

Actinomyces nivea. (Incorrectly attributed to Krainsky, 1914 by Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270.)

Actinomyces nondiastaticus Bergey et al. (Var. b. Bergey, Jour. Bact., 4, 1919, 301; Bergey et al., Manual, 1st ed., 1923, 371.) From air.

Actinomyces ochraceus Neukirch. (Ueber Actinomyceten, Strassburg, 1902,

4.) From soil.

Actinomyces ochroleucus Neukrich. (Ueber Actinomyceten, Strassburg, 1902, 4.) From soil.

Actinomyces odorifera Koelz. (Insug Diss., Kiel, 1934; Le Lait, 18, 1936, 154.) Actinomyces oligocarbophilus Lantzsch. (Lantzsch, Cent. f. Bakt., H Abt., 57, 1922, 309; Proactinomyces oligocarbophilus Krassilnikov, Bull, Acad. Sci., U. S. S. R., No. 1, 1938, 139.) Lantzsch regards this organism as identical with Bacillus oligocarbophilus Beijerinck and Van Delden, Cent. f. Bakt., II Abt., 10, 1903, 33 (Carboxydomonas oligocarbophila Orla-Jensen, Cent. f. Bakt., II Abt., 23, 1909, 311). Secures growth energy by oxidizing CO to COr. From soil. See Manual, 5th ed., 1939, 81 for s description of the bacillary stage of this organism. Carboxyodomonas oligocarbophila Orla-Jensen is the type species of the genus Carboxydomonas Orla-Jensen (loc. cit.).

Actinomyces orangica-niger. (Quoted from Lieske, Morphol. u. Biol. d. Strahlenuilze, Leipzig, 1921, 33.)

Actinomyces orangicus. (Quoted from Lieske, Morphol. u. Biol. d. Strahlenpilze, Leipzig, 1921, 33.)

Actinomyces pelogenes Sawjaluw.

(Cent. f. Bakt , II Abt , 39, 1913, 440 )

Actinomyces pluricolor Terni. (Streptothriz pluricolor Fuchs; Terni, quoted from Gasperini, Cent. f. Bakt, 15, 1894, 684, Nocardia pluricolor Chalmers and Christopherson, Ann. Trop Med and Parasit. 10, 1916, 2683.

Actinomyces pluricolor diffundens Berestnew. (Insug. Diss., Moskow, 1897; see Cent f Bakt., I Abt., 24, 1898, 708.) From sir.

Actinomyces praecox Millard and Burr (Ann. Appl Biol., 13, 1926, 601) From scab on potato

Actinomyces praefecundus Millard and Burr. (Ann. Appl. Biol., 15, 1926, 601.) From seab on potato and from soil Actinomyces protea (Schurmayer) Ford. (Oospora proteus and Streptothra Proteus Schurmayer. Cent. f Bakt. I

Abt., 27, 1900, 58; Ford, loc. cit, 208) From an abscess of the foot

Actinomyces pseudotuberculosae (Flexner) Brumpt. (Streptothriz pseudotuberculosa Flexner, Jour. Evp Med, 3, 1898, 138; Brumpt, Précis de Parasit, Paris, 4th ed., 1997, 1206)

Actinomyces pseudotuberculous Lehmann and Neumann. (Actinomyces atypica pseudotuberkulosa Hamm and Keller, Cent f. Bakt, T Abt, Ref. 42, 1909, 729; Lehmann and Neumann, Bakt. Diag, 5 Aufl, 2, 1912, 621, Nocardia pseudotuberculoss de Mello and Fernandes, Mem Asiatic Soe Bengal, 7, 1919, 110)

Actinomyces purpureus Killian and Fehér (Ann Inst. Part, 55, 1935, 620)

From desert soil.

Actinomyces putoris (Dick and Tunnichiff) Ford (Streptothrix putoris Dick

citil) Ford (Streplothrix pulorii Dick and Tunnichiff, Jour. Inf. Dis., 23, 1918, 183, Ford, Texth of Bact., 1927, 216.) From the blood of a patient bitten by a weasel.

Actinomyces pyogenes Larske (Line neue Streptothrixspecies, Canuniti, Cent. f. Rakt., I Abt., Orig., 44, 1907, 193; Streptothrix pyogenes Chalmers and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 270, Lieske, Morphol u Biol. d. Strahlenpilze, Leipzig, 1921, 32.) From air.

Actnomyces radiatus Namyslowski. (Namyslowski, Cent. f. Bakt. J. Abt., Orig., 62, 1912, 564; Streptothriz radiatus Chaliners and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273. Nocardus radiata Vuillemin, Encyclopédie Mycologuqe, Paras, 2, 1931, 126. From an infection of the cornea of the human eve.

Actinomyces rosaceus. (Quoted from Lieske, Morphol u. Biol d Strahlenpilze, Leipzig, 1921, 33.)

Actinomyces roseodiautaticus Duché. (Encyclopédie Mycologique, Paris, 6, 1931, 329)

Actinomyces roseus Namyslowski. (Actinomyces sp. Lowensteins Klin. Monatsbl. f. Augenheilk, 48, 1910, 185; Namyslowski, Cent. f. Bakt, I. Abt., Org, 62, 1912, 567; not. Actinomyces roseus Krainsky, Cent. f. Bakt, II. Abt., 41, 1914, 602; Discomyces roseus Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 981.)

Actinomyces saharae Killian and Feliér. (Ann Inst Past., 55, 1935, 621) From desert soil

Actinomyces salmonicolor Millard and Burr (Ann Appl. Biol , 15, 1926, 601.) From sour soil.

Actinomyces sampsonis Millard and Burr (Ann Appl Biol., 15, 1926, 601.) From scab on potato.

Actinomyces sanguints Rusu (Ind. Jour Med Res., 25, 1937, 325.) From the blood of a patient with bronchial pneumonia

Actinomyces sannini Ciferri. (Quoted from Baldacci, Boll Sez. Ital Soc. Internaz di Microbiol, 9, 1937, 140)

Actinomyces scionii Millard and Burr. (Ann Appl. Biol , 15, 1926, 601.) From scab on potato

Actinomyces spiralis Millard and Burr. (Ann. Appl. Biol., 15, 1926, 601.) From decaying grass.

Actinomyces taraxeri cepapi (Schottmuller) Ford (Streptothrix taraxeri cepapi Schottmüller, Dermat. Wchnschr., 53, 1914, Supplement, 77; Ford, loc. cit., 196.) From a case resembling rat-bite fever following the bite of a South African squirrel (Tarazerus cepapi).

Actinomyces tenuis Millard and Burr. (Ann. Appl. Biol., 13, 1926, 691.) From

scab on potato.

Actinomyces thermodiastaticus Bergey et al. (Var. a, Bergey, Jour. Bact., 4, 1919, 301; Bergey et al., Manual, 1st ed., 1923, 370.) From stomach contents of a rabbit.

Actinomyccs thermotolerans Stadler. (Arch f Hyg., 33, 1899, 40.) From milk and butter.

Actinomyces variabilis Cohn. (Cent. f Bakt, I Abt., Orig., 70, 1913, 301.) From pus in the bladder in a case of cystitis, and from the prostate.

Actinomyces terrucosus Nadson. (Nadson, Die Mikroorganismen als geologische Faktoren I. Petersburg, 1903; quoted from Dorff, Die Eisenorganismen, Pflanzenforschung, Jena, Hett 16, 1934, 43; not Actinomyces verrucosus, Adler, 1901, see Nannizzi, in Follacus, Tratt. Micopat Umana, 4, 1934, 46.) From sea mud Deposits ferrie hydroxide about the mycelial threads.

Actinomyces violaceus (Rossi Doria) Gasperini. (Streptotri violacea Rossi Doria, Ann. d. 1st. d'Ig. sper. d. Univ. di Roma, I., 1891, 411; Oespora violacea Sauvageau and Radais, Ann Inst. Past., 6, 1892, 282; Gasperini, Cent. f. Bakt., 16, 1894, 684; Cladolhrix violacea Macc, Traité Pratique de Bact., 4th ed., 1901, 1075; Nocardia violacea Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270; Discomyces violaceus Brumpt, Précis de Parasitoli., Paris, 3rd ed., 1922, 995) From air and water. Actinomyces virlais (Lombardo-Pelle-

grino) Saufelice. (Streptothriz viridis Lombardo-Pellegrino, Riforma Med., 18, 1903, 1965; also see Cent. f. Bakt., I Abt., Ref. 25, 1904, 761; Sanfelice, Cent f. Bakt., I Abt., Orig., 86, 1904, 355.) From soil

Actinomyces viritis Millard and Burr.

(Millard and Burr, Ann. Appl. Biol., 15, 1926, 601; not Actinomyces viridis Sanfelice, Cent. f. Bakt., I. Abt., Orig., 35, 1904, 335; not Actinomyces viridis Duché, Encyclopédie Mycologique, Paris, 6, 1934, 311.) From scab on potato.

Actinomyces xanthostromus Wollenweber. (Arb. Forschungsinst, f. Kar-

toffelbau, 1920, 16.)

Actinomyces wedmorensis Millard and Burr. (Ann. Appl. Biol., 15, 1926, 601.) From peat soil.

Astroides liesLey! Puntoni and Leonardi. (Boll. e Atti d. R. Accad. Med. di Roma, 61, 1935, 94.) A renaming of Actinomyces lieskey, a culture whose source was unknown. This may possibly be the same as Actinomyces lieskei. Duché (see Streptomyces lieskei.)

Cladothrix odorifera Rullmann. (Rullmann, Inaug. Diss., Munich, 1895; see Cent. f. Bakt., I Abt., 17, 1895, 881 and Cent. f. Bakt., I Abt., 21, 1896, 316; Oospora odorifera Lehmann and Neumann, Bakt. Diag., 1 Aufi., 2, 1896, 302; Actinomyces odorifer Lachner-Sandoval, Ueber Strahlenpilze, 1898, 65; Strepto-thriz odorifera Foulerton and Jones, Trans. Path. Soc. London, 53, 1902, 112; Nocardia odorifera Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 818.) From sputum in a case of chronic

bronchitis.
Cladothriz placoides Kligler. (Leptothriz placoides alba Dobrayniccki, Cent. I. Bakt., 1 Abt., 21, 1807, 225; Kligler. Jour. Allied Dental Soc., 10, 1015, 141, 282 and 445; Leptotrichia placoides Bergey et al., Manual, 3rd cd., 1903, 458.) From a tooth canal. For a description of this species see Manual, 5th ed., 1939, 829. The description indicates that this organism belongs to Nocardia or Streptomyces.

Coccobacillus pseudo - actinomycosis polymorphus Berestneff. (Berestneff, 1898, quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273)

Cohnistreptothrix americana Chalmers and Christopherson. (Streptothrix 29.

Bloomfield and Bayne-Jones, Johns Hopkins Hosp. Bull. 26, 1915, 230; Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 273; Actinomyces americanus Dodge, Medical Mycology, St. Louis, 1935, 716) From a liver abseess.

Cohnistreplothrix misri Carpano (Riv. di Parasit., No. 2, 1937, 197.) From human dermatosis in Egypt

Cohnistrepichtitz silberschmidlit Chalmera and Christopherson. Streptchirty, Silberschmidt, Cent. f. Bakt., I Abt., 27, 1909, 486, Chalmers and Christopherson, Ann Trop Med. and Parasit., 10, 1916, 273, Nocardia silberschmidli Froilano de Mello and Fernandes, Mem. Anatic Soc. Bengal, 7, 1919, 111; Actinomyces silberschmidt Dodge, Medical Mycology, St. Louis, 1935, 711) From cases of daeryocystitis.

Discompces decussatus Langeron and Chevallier. (Langeron and Chevallier, Compt. rend. Soc. Biol., 72, 1912, 1930; Nocardia decussata Castellan and Chalmers, Man. Trop. Med., 2nd ed., 1913, 817; Ospora decussata Sartory, Champ. Paras. Homme et Anim., 1923, 253; Actinomyces decussatus Brumpt, Précis de Parasitol, 4th ed., 1927, 1206.) From dry, scaly lesions. Not considered pathogenie

Nocardia chalmersi de Mello and Fernandes. (De Mello and Fernandes, Mem Assatte Soc. Bengal, 7, 1910, 130; Actinomyces chalmersi Dodge, Medical Mycology, St. Louis, 1935, 734.) From the saliya of a horse.

Nocardia christophersons de Mello and Fernandes. (De Mello and Fernandes, Mem Asiatic Soc. Bengal, 7, 1919, 130; Actinomyces christophersoni Dodge, Medical Mycology, St. Louis, 1935, 723.) From the air.

Nocardia cutra Chalmers and Chrisropherson. (Ann. Trop. Med. and Parasit., 10, 1916, 270.) A blanket name proposed to include Actinomyces griscofacus Krainsky, Actinomyces farus Krainsky, Streptoláriz fara Sanfelice and Streptoláriz fara Brans Nocardia cruoris Macfie and Ingram. (Macfie and Ingram, Ann. Trop. Med. and Parasit., 15, 1921, 283; Discompces cruoris Brumpt, Précis de Parasitol., Paris, 3rd ed., 1922, 984; Oospora cruoris Sartory, Champ. Paras. Homme et Anim, 1923, 809; Actinomyees cruoris Brumpt, tbid., 4th ed., 1927, 1195.) From blood.

Nocardia dichotoma (Macc) Chalmers and Christopherson. (Cladothriz dichotoma Macc, Compt. rend. Acad. Sci. Paris, 6, 1888, 1622; not Cladothriz dichotoma Cohn, Beitr. z. Biol d. Pflanzen 1, Heft 3, 1875, 185; Chalmers and Christopherson, Ann. Trop. Med. and Parastt., 10, 1916, 270.)

Nocardia Ierrujinca Trevisan. (Bakterium bei Chorea St. Viti, Naunyn, Mittheil. aus der Med. Klimik zu Königsberg, 1888, 292; Trevisan, I generi e le specie delle Batteriace, 1889, 9, Attinomyces ferrugineus Gasperini, Cent. f. Bakt., 18, 1891, 631) From pia mater in a case of St. Vitis' dance.

Nocardia garteni (Brumpt) Castellani and Chalmers. (Clodothrz Lucuforums No. 2, Garten, Deutrele Zitchr. f. Chirurg. 41, 1858, 422; Dietemyce garteni Brumpt, Prices de Parasitol, Patis, 1st ed., 1910, 800; Cestellari ard Chalmers, Man. Trep. Med., 2rd ed., 1913, 818; Oospora garteni Entrery, Charrp. Paras. Homne et Anim. 1923, 778; Actinomyces garteni Brumpt, loc. ett., 4th ed. 1927, 1931; Actinomyces liquefactens Ford, Texth. of Bact., 1927, 202.) From cases of human actinomycosis.

Nocardia gonnis de Mello and Fernandes. (De Mello and Fernandes, Mem Asiatic Soc. Bengal, 7, 1919, 130; Actinomyces goensis Dodge, Medical Mycology, St. Louis, 1975, 723) From Jesions of vitiligo. Saprophytic.

Nocardia liguire Urizer. (Urizer, 1901; Actinomices liguire Nannizzi, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 49.)

Nocardia liquefaciens (Hesse) Castel-

lani and Chalmers. (Cladothriz liquefaciens Hesse, Deutsche Ztschr. f. Chirurg., 41, 1895, 432; Discomyces liquefaciens Brumpt, Précis de Parasit., Paris, 1st ed., 1910, 800; Castellani and Chalmers, Man. Trop. Med., 2nd ed., 1913, 816; Streptothriz liquefaciens Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 233, 265; Oospora liquefaciens Sartory, Champ. Paras. Homme et Anim., 1923, 778; Actinomyces liquefaciens Brumpt, loc. cil., 4th ed., 1927, 1192.) From an inguinal absecss.

Nocardia microparva Chalmers and Christopherson. (Ann. Trop. Med. and Parasit., 10, 1916, 268.) Listed as synonymous with Actinomyces microparva Krainsky, 1914 which may be intended for Actinomyces microflavus Krainsky, Cent. f. Bakt., II Abt., 41, 1914, 662.

Nocardia orangica (Berestueff) Chalmers and Christopherson. (Streptohriz orangica Berestneff, Inaug. Diss., Moscow, 1897, quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 271; Chalmers and Christopherson, idem.)

Nocardia rogersi de Mello. (Nocardia (Colnistreptothriz) rogersi de Mello, A Med. Contemp., 1919; Discomyces rogersi Neveu-Lemaire, Précis Parasitol. Hum., 5th ed , 1921, 44; Actinomyces rogersi: Brumpt, Précis de Parasitol., 4th ed , 1927, 1206) From sputum.

Nocardia rubea Chalmers and Christopherson (Ann Trop Med and Parasit, 10, 1916, 271) Nomen nudum According to Dodge (Medical Mycology, St. Louis, 1935, 765), this is a synonym of Dospora rubra Wilbert, Recueil Hyg. Méd. Vét. Militaire, 1999.

Nocardia saprophytica Chalmers and Christopherson. (Streptothriz leucea saprophytica Foulerton, 1902, quoted from Chalmers and Christopherson, Ann Trop. Med. and Parasit, 10, 1916, 270; Chalmers and Christopherson, idem.)

Nocardia urinaria Pijper. (Pijper,

1918, quoted from Castellani and Chalmers, Man. Trop. Med., 3rd ed., 1919, 1957; Actinomyces urinarius Nanniri, in Pollacci, Tratt. Micopat. Umana, 4, 1934, 50)

Oospora hoffmanni (Gruber) Sauvageau and Radais. (Milromuces hofmanni (sic) Gruber, Trans. Int. Congr. Hyg. Derm., VI, 2, 1891-1892, 65 and Arch. f. Hyg., 16, 1893, 35; Sauvageau and Radais, Ann. Inst. Past., 6, 1892. 251; Actinomyces hoffmanni Gasperini, Cent. f. Bakt., 15, 1894, 684; Streptothriz hofmanni Kruse, in Flugge, Die Mikroorganismen, 3 Aufl., 2, 1896, 62; Cladothriz hoffmanni Mace, Traité Pratique de Bact., 4th ed., 1901, 1081; Nocardia hoffmanni Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 268.) From a sample of vaccine. .

Osspora spumalis Sartory. (Sartory, in Sartory and Bailly, Mycoses pulmonaires, 1923, 318; Actinomyces spumalis Dodge, Medical Mycology, St. Lauis, 1935, 751.) From human sputum.

Streptothriz aaser Johan-Olsen. (Inaug. Diss., Christiania, 1893, 91; quoted from Neukirch, Ueber Actinomyceten, Strassburg, 1902, 69.)

Streptothriz alpha Price-Jones. (Price-Jones, 1900; quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270.) Considered synonymous with Streptothriz alba (Rossi Doria).

Streptothriz aquatilis Johan-Olsen. (Inaug. Diss., 1893, 93; quoted from Johan-Olsen, Cent. f. Bakt., II Abt., 5, 1897, 279.)

Streptothriz beta Price-Jones. (Price-Jones, 1900; quoted from Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 270; Nocardia beta Chalmers and Christopherson, idem.) Streptothriz chondri Johan-Olsen.

Streptothriz chondri Johan-Olsen. (Inaug. Diss., 1893, 95; quoted from Johan-Olsen, Cent. f. Bakt., II Abt., 5, 1897, 278.)

Streptothriz enteritidis Pottien. (Quoted from Sanfelice, Cent. f. Bakt., I Abt., Orig , 36, 1904, 355.) Streptothriz foersteri Gasperini. (Gasperini, Annales de Micrographie, g. 1800, 462, not Streptothriz foersteri Cohn, Beitr. z. Biol. d. Pflancen, f. Heft 3, 1875, 1965, detinomyces approphyticus Gasperini, Ann. d. Ist. d'Ig. sper. d. Univ. Roma, g. 1892, 263, detinomyces approphyticus var. cromogenus Gasperini, ibd. 229) From air.

Streptothriz gelatinosus Johan-Olsen. (Cent f. Bakt., II Abt., 5, 1897, 279.) Streptothriz humufica Johan - Olsen (Cent. f. Bakt., II Abt., 5, 1897, 278.) Streptothriz lemani Johan-Olsen. (Inaug. Diss., 1893, 96; quoted from Johan-Olsen, Cent. f. Bakt., II Abt.,

1897, 279.)
 Streptothrix necrophora Wilhelm.
 (Monats. f. prakt. Tierheilk., 14, 1902, 193.)
 See page 578

Streptothrix leucea Foulerton. (In Allbutt and Rolleston, Syst. of Med, 2, 1912, 310)

Streptothriz melanotica Price-Jones-(On the General Characteristics and Pathogenic Action of the Genus Streptothriz, 1901; also see Foulerton, in Allbutt and Rolleston, Syst. of Med., 2, 1912, 301.)

Streptothrix ordieformis Johan-Olsen.

(Inaug. Diss , 1893, 96; quoted from Neukirch, Ueber Actinomyceten, Strassburg, 1902, 69)

Streptothriz spirilloides Johan-Olsen (Innug. Diss, 1893, 96; quoted from Neukirch, Ueber Actinomyceten, Strassburg, 1902, 69.)

Streptothriz tartari Sanfelice. (Cent. f. Bakt., I Abt., Orig., \$6, 1904, 355.)

Streptothriz wallemia Johan-Olsen. (Inaug Diss., 1893, 96; quoted from Neukirch, Ueber Actinomyceten, Strassburg, 1902, 69.)

Streptothriz zopfi Casagrandi. (Quoted from Caminiti, Cent. f. Bakt., I Abt., Orig., 44, 1907, 198.)

Drechsler (Botan. Gazette, 67, 1919, 65 and 147) described eighteen morphological types of Actinomyces (Streptomyces). The relationships of these types to apecies previously described in the literature are not explained except in four instances. Actinomyces II is regarded as Actinomyces actinomyces X is regarded as Actinomyces X is regarded as Streptothriz all Rossi Doria (possibly Actinomyces graevus Kminsky); Actinomyces XII is regarded as Streptothriz all Rossi Doria (possibly Actinomyces graevus Kminsky); Actinomyces XII is regarded as Actinomyces XII is regarded as Actinomyces actinomyces XII is Actinomyces scales Güssow.

# Genus II. Micromonospora Ørskov.

(Orskov, Investigations into the morphology of the ray fungi. Copenhagen, 1923, 147; includes Thermoactinomyces Tsilinsky, Ann. Inst. Past., 18, 1899, 501; ibid., 17, 1903. 206.)

Well developed, fine, non-septate mycelium, 0.3 to 0.6 micron in diameter. Grow well into the substrate. Not forming at any time a true aerial mycelium. Multiply by means of conidia, produced singly at end of special conidiophores, on surface of substrate mycelium. Conidiophores short and either simple, branched or produced in clusters. Strongly proteolytic and diastatic. Many are thermophilic and can grow at 65°C. Usually saprophytes. These organisms occur mostly in hot composted manure, dust, soil and in lake bottoms.

The type species is Micromonospora chalcea (Foulerton) Orskov.

# Key to the species of genus Micromonospora (Orskov Group III).

- Vigorously growing organisms, typically with copious spore formation on glucoseasparagine-agar.
  - A. Vegetative mycelium pale pink to deep orange, no typical soluble pigment.

    1. Micromonospora chalcen.
  - B. Vegetative mycelium orange changing to brownish-black, brown soluble pigment.
  - 2. Micromonospora fusca.
- Slowly and feebly growing organisms, with scant spore formation on glucoseasparagine-agar, no soluble pigment.
  - A. Vegetative mycelium pale pink to pale orange.
    - 3. Micromonospora parva.
  - B. Vegetative mycelium yellow to orange-red.
    4. Micromonospora globosa.
  - C. Vegetative mycelium blue.
    - 5. Micromonospora vulgaris.

Note: This genus could be subdivided on the basis of the relations of the organisms to temperature, since it includes a number of thermophilic forms which grow readily at 55° to 65°C, mesophilic forms having their optimum temperature at 30°C, and organisms growing at low temperatures in lakes. Each of these can be divided into 3 groups, based on the structure of the spore-bearing hyphae. Among the thermophilic forms, only representatives of the first group have so far been isolated in pure culture although the existence of the other two groups has definitely been demonstrated in microscopic preparations. These are:

Group 1. Simple spore-bearing hyphae.

Group 2 Branching spore-bearing hyphae.

Group 3. Spore-bearing hyphae in clusters.

1. Micromonospora chalcea (Foulerton) Orskov. (Streptothriz chalcea Foulerton, Lancet, t, 1905, 1200, Nocardia chalcea Chalmers and Christopherson, Ann. Trop Med and Parasit, 10, 1916, 268; Orskov, Thesis, Copenhagen, 1923

Bact., 1927, 221.) From Greek chalceus, bronze.

Description from Jensen, Proc. Linn. Soc New So. Wales, 57, 1932, 173.

Formation of a unicellular mycelium which forms distally placed, singly situated spores No serial hyphae. No sur-

face growth in liquid medium. The avantism regists designation for at least 8 months Comparison between the power of resistance of the mycelium and the spores, respectively, will no doubt present great difficulty because it is almost impossible to ensure that the two constituents are actually detached Otherwise the mycelium is but slightly capable of germinating which may be ecceptained by ineculating a water sear plate liberally with a mixture of mycelial threads and spores. While practically all the spores germinate, the mycelial threads were never found to form new colonies

Vegetative mycelium on glucose-asparagine-agar: Heavy, compact, raised, pale nink to deep orange not spreading much into the medium. Spore-layer well developed moist and glistening brownish-black to greenish-black, this color cometimes spreading through the whole mass of growth.

Gelatin is liquefied.

Grows in liquid media as small firm orange granules or flakes

Milk is digested with a faintly acid reaction, mostly after a previous cosquia-+ion

Some strains produce nitrates from nitrates

Starch is hydrolyzed

Many situos invert sucrose

Most strains decompose cellulose Proteolytic action seems stronger in this

than in the other species of this cenus Ontimum temperature for growth 30° to 35°C Thermal death point of mycelium, 70°C in 2 to 5 minutes resist 80°C for 1 to 5 minutes.

Habitat . Soil, lake mud and other substrates. In addition to the above references, see Erakson (Jour Bact., 41. 1911, 279) and Umbrest and McCov (A Symposium on Hydrobiology, Univ of Wisconsin Press, 1941, 106-114).

2 Micromonospora fusca Jensen (Proc. Lann Soc. New So. Wales, 87. 1932, 178.) From Iatin fuscus, dark.

Veretative mycelium on chrose-eeparagine-agar heavy compact orange rapidly changing to deep brown and nearly black: enore-layer moiet glistening gravish to brownish-black. Deen brown soluble nigment

Gelatin is liquefied

Grove in liquid media as small brown granules and flakes

Milk is slowly digested no cosmilation Suameo is inverted

Reduction of natrates positive or necestimo

Collubration to a shight extent Starch is hydrolyzed.

Habitat - Soil

3. Micromonospora parva Jensen. (Proc Lann. Soc. New So Wales, 57. 1932, 177 ) From Latin parrus, small,

Scint growth on glucose-asparagineagar: vegetative mycelium thin appreading widely into the agar, almost colorless to pale pink or orange. Sporulation scant, giving rise to thin gravish, moist cruete on the surface

Gelatin is liquefied.

Milk is left unchanged; or congulated. slowly redissolved with faintly acid reac-

Sucrose not inverted.

Nitrates not reduced Cellulose not decomposed.

Starch is hydrolyzed

Habitat Soil

4. Micromonospora globosa Krassilni-Loy. (Ray Fungi and Related Orcanisms Izd Acad, Nauk, Moskow. 1938, 134, Microbiology, U. S. S. R., 8. 1939, 179 ) From Latin globosus, spheriml

A fine (0.5 to 0.8 micron in diameter) monopodially branching my celium. This mycelium breaks soon into separate pieces of varying length and irregular outline. Conidia are formed at the ends of short branches, one on each India vidual branches with conidus resemble grape sines. The conidus are subcrical 10 to 13 microns; they arme by the

swelling of the branch tips. The swellings become round, acquire the shape of spheres, which, as the formation of the condida proceeds, are divided from the branch by a transverse soutum.

Gelatin is liquefied.

Colonies: Rugose, at first very compact, later acquire a pasty consistency, and their bond with the medium becomes not so fast. The color of the cultures varies from light yellow to orange-red. During fruit-bearing the colonies are covered with a brownish-black tarnish of condita.

In meat-peptone broth, ammonia is produced.

Milk: Casgulation; peptonization. Nitrites are produced from nitrates. Sucrose is inverted. Cellulose not decomposed. Starch is hydrolyzod. Habitat: Soil.

5. Micromonospora vulgaris (Tsilinsky) Waksman, Umbreit and Gordon. (Thermophile Cladothrix, Kedzior, Arch. Hyg., 27, 1896, 328; Thermoactinomuces pulgaris Tsilinsky, Ann. Inst Past , 13, 1899, 501; Actinomyces monosporus Schutze, Arch. f. Hyg., 67, 1908, 50 (Nocardia monospora Chalmers and Christopherson, Ann. Trop. Med. and Parasit., 10, 1916, 271), Actinomyces glaucus Lehmann and Schutze, in Lehmann and Neumann, Bakt Diag 5 Aufl., 2, 1912. 641 (Nocardia glauca Chalmers and Christopherson, loc. cit.); Micromonosnora coerulea Jensen, Proc. Linn. Soc. New So. Wales, 57, 1932, 177; Waksman, Umbreit and Gordon, Soil Sci., 47, 1939. 51.) From Latin vulgaris, common.

Morphologically the development of this organism is entirely comparable to that of the mesophilic form described by Jensen. The young mycelium shows slightly more branching than that produced by species of Streptomyces. Spores are borne at the end of short branches from which they are easily broken. The aerial mycelium, though present, is usually rudimentary, rarely exhibiting the tangled network of strands

typical of species of Streptomyces. Thermophilic strains of Micromonospora rulgaris differ thus from the nesophilic forms, which show no trace of aerial my-celium. Fragmentation has not been seen in slide cultures of the organism thus far isolated, but it was found to occur in smear preparation.

According to Jensen, the mesophile strains grow slowly on glucos-agazagine-agar; vegetative mycelium dense, dark greenish-blue, with a hard and glossy surface. Sporulation very scant. The surface sometimes shown a thin white veil resembling aerial mycelium, but without aerial spores.

Gelatin: Liquefaction.

Good growth on beef-peptone sgar, potato, milk, beef-peptone broth, etc. Grows in liquid media as fairly large, firm, round, white to pink granules (Jensen). Usually a white, pondery, thin aerial mycelium is produced which is hardly raised above the surface. No soluble bigment is formed.

Czapek's agar : Growth white, powdery,

slightly raised.

Broth: A tough white pellicle and in many instances a considerable number of ball-like colonies at the bottom of the tube. No turbidity.

Milk: Coagulated and digested.

Nitrites not produced from nitrates.

Sucrose not inverted.

Cellulose not decomposed.

Starch is hydrolyzed.

Optimum temperature of thermophilic forms 57°C. Growth range 48° to 68°C. Habitat: Straw, soil, high temperature composis.

Appendix: The following anaerobic species has been described:

Micromonospora propionici Hungate. (Abst. in Jour Bact., 18, 1914, 380 and 490; Jour Bact., 81, 1916, 51.) From the alimentary tract of the wood-enting termite (Amilermes minimus). Ferments glucose or cellulose to form acetic and propionic acids and CO<sub>2</sub>. Obligate annerobe.

### ODDED III CHIAMVDORACTERIATES RUCHANAN

(Jour. Bact., 2, 1917, 162.)

Filmentous, colorless, alga-like batteria. May or may not be ensheathed. They may be unbranched or may show false branching. False branching arises from a lateral displacement of the cells of the filment within the sheath which gives rise to a new filment, so that the sheath is branched while the filments are separate. The sheath may be composed entirely of ron hydroude, or of an organic matrix impregnated with iron, or may be entirely organic. The filments themselves may show motifulty by a gliding movement like that found in the blue-green algae (Oscillatoraccea) Condia and motife fingellate swarm cells may be developed, but never condensors. Fresh water and marine forms.

### Key to the families of order Chlamydobacteriales.\*

- I Alga-like filaments which do not contain sulfur globules False branching may occur.
  - Λ Usually free floating filaments Motile swarm cells may be formed.
    Family I Chlemydobacteriaceae, p. 981
  - B Attached filaments which show a differentiation of base and tip Non-motile coulds formed in the swellen tus of the filaments
- Family II Crenothrichaecae, p. 987.

  II Alga-like, unbranching filaments which may contain sulfur globules when growing in the presence of sulfides. Filaments may be motile by a creeping or sliding movement along a solid substrate.

Family III Bengiatogceae, p. 988.

## PAMILY I. CHLAMYDOBACTERIACEAE MIGULA.\*\*

(Arb. Bakt. Inst. Hochschule, Karlsruhe, 1, 1891, 237)

Filamentous bacteria which frequently show false branching Sheaths may or may not be impregnated with ferric hydroxide. Cells divide only transversely. Swarm cells, it developed, are usually motile by means of fligella Usually found in tech water.

## Key to the ocnera of family Chlamydobacteriaceae.

- 1 Showing typical false branching
  - A Sheaths entirely organic, not impregnated with ferric hydroxide

    Genus I Sphacrotilus, p. 982
    - B. Sheaths impregnated with ferric hydroxide
- Genus II Clonothriz, p 993.
  - A. Sheaths or holdfasts impregnated with terric hydroxide

    Genus III Leptothrix, p. 983

<sup>•</sup> In Appendix I, p. 996, will be found a group of non-filamentous, non-sheath-forming, coloriers sulfur bacteria, as the family Achromatisecae. Their true relationships are as yet obscure, and they have been attached as an Appendix to the Cliamy Islandericales largely on account of the aimilarity of their metabolism to that of the Begindoncae.

<sup>\*\*</sup> Completely revised by Prof. A. T. Henrici, University of Minnesota, Minneapolis, Minnesota, December, 1935; further revision by Prof. Robert S. Breed, New York State Experiment Station, General, New York, July, 1916.

# Genus I. Sphaerotilus Kūtzing. (Kutzing, Linnaea, 8, 1833, 385; Cladothrix Cohn, Beitr. z. Biol. d. Pflanz., 1,

Attached, colorless threads, showing false branching, though this may be rare in some species. Filaments consist of rod-shaped or ellipsoidal cells, surrounded by a firm sheath. Multiplication occurs both by non-motile conidia and by motile swarm cells, the latter with lophotrichous flagella,

The type species is Sphaerotilus natans Kutzing.

Heft 3, 1875, 185 ) From Greek sphaera, sphere.

 Sphaerotilus natans Kutzing. (Kutzing, Linnaen, 8, 1833, 385; not Sphacrotilus natans Sack, Cent. f. Bakt .. II Abt , 65, 1925, 116; Cladothrix natans Migula, in Engler and Prantl, Die natürl Pflanzenfam. 1, 1a, 1895, 46.) From Latin natans, swimming.

Cells cylindrical, surrounded by a sheath which is slimy in character, 2 to 3 microns in diameter. False branching

Multiplication occurs through the formation of conidia within the sheath of the vegetative cells, from which they swarm out at one end, swim about for a time, then attach themselves to objects and develop into delicate filaments

Gelatin rapidly liquefied, requires organic nitrogen, does not grow in the ordinary peptone solution, grows best with low concentrations of meat extract (Zikes, Cent f. Bakt , II Abt., 48, 1915,

The culture cultivated and described as Sphaerotilus natans by Sack (Cent. f Bakt , II Abt , 65, 1925, 116) was identified as Bacillus mycoides by Hang (ibid . 69, 1926, 4)

Source Originally found in polluted waters. May become a real nuisance in sewage purification plants of the activated sludge type (Lackey and Wattie, U. S. Pub. Health Ser., Pub Health Repts., 55, 1940, 975) and in streams polluted with sulfite liquor from pulp and paper mills (Lackey, Mimeographed Rept. U. S Pub. Health Ser , 1941).

Habitat: Stagnant and running water, especially sewage polluted streams.

Sphaerotilus dichotomus (Cohn) Migula. (Cladothrix dichotoma Cohn,

Beitr. z. Biol. d. Pflanz., 1, Heft 3, 1875, 185; Migula, Syst. d. Bakt., 2, 1900, 1033; Sphaerotilus natans var, cladothrix Butcher, Trans. Brit. Myc. Soc., 17, 1932, 112.) From Greek dichotomos, cut in two parts, forked.

The identity of this species as distinct from Sphaerotilus natans has been questioned. Cohn's description applied to filaments 03 micron in diameter, while all later authors have applied the name to a much larger organism (2 to 4 microns in diameter).

Zikes (Cent. f. Bakt., II Abt., 43, 1915, 529) gives the following differential characters: Cells smaller than Sphaerotilus natans, 1.5 to 2.5 microns; false branching constant; grows best in high concentrations of meat extract; will grow in ordinary peptone solutions; can utilize inorganic nitrogen; liquefies gelatin slowly

Source · Found by Cohn in water containing Myconostoc.

Habitat. Comparatively unpolluted fresh water capable of sustaining algae.

3. Sphaerotlius fluitans (Migula) Schikora. (Streptothrix fluitans Migula, in Planzen.

fluitans Migula, Syst d Bakt., 2, 1900, 1033; Leptothrix Stuttans Chester, Man. Determ. Bact., 1901, 370) From Latin flustans, flowing, floating.

Very thin attached filaments surrounded by a soft sheath, from which almost spherical conidia issue, usually attaching themselves to the exterior of the sheath, where they multiply.

Habitat, Swamp water or sewage pol-

Appendix: Additional species have been described as belonging in this genus. Those described by Ravenel have generally been overlooked although he was ore of the earliest workers to culture these oreansms. The list follows:

these organisms. The last follows:

Cladothrix fungiformis Ravenel.

(Mem Nat Acad. Sci., 8, 1896, 19)

From deep virgin soil

Cladothrix intestinalis Ravenel (loc. cit, 18) From virgin soil.

cit, 18) From virgin soil.

Cladothrix non-liquefaciens Ravenel

(loc. cit, 16). From deep made soil.

Cladothrix profundus Ravenel (loc cit. 17). From deep made soil.

Cladothriz ramosa Gasperini. (Atti d Soc. toscana d'Ig, 2, 1912, 000)

From water.

Cladothriz reticularis Naumann (Kungl. Svenska Vetonskapsakad Handl., I, 62, Part 4, 1921, 44; Sphaerotilus reticularis Cataldi, Thesis, Univ. Buenos Aires, 1939, 55.) From Aneboda region, Saeden.

Sphaerotilus roseus Zopf. (Beiträge

men 1892, 32.) From water.

#### Genus II Clonothrix Roze.

(Jour d Bot , 10, 1896, 325.) From Greek klon, a twig and thriz, hair. Attached filaments showing false branching as in Sphaerotilus. Sheaths organic,

the younger portion of the filaments

The type species is Clonothriz fusca Roze.

1 Clonothrix fusca Roze. (Roze, Jour d. Bot., 10, 1896, 325, Clonothrax fusca Schorler, Cent. f Bakt, II Abt., 12, 1901, 689, Crenothrax fusca Dorff, Due Freenorganismen, Pflanzenforschung, Heft 16, 1934, 41) From Latin fuscus, brown.

Cells cylindrical with rounded ends, 2 by 10 microns, becoming larger toward the base and smaller toward the tips of the filaments

Shouths 7 microns at the base to 2 microns at the tips

Condia about 2 microns in diameter. This organism was described by Hoze as a blue green alga, but subsequent observers have failed to find pigment. It was described independently by Schotler who gave it the same name Cholodny considered it identical with Cernothray polypora but Kolk (Amer Cernothray polypora but Kolk (Amer).

Jour. Bot , 25, 1938, 11) has clearly differentiated these species.

Habitat, Waterworks and pipes.

Appendix: Apparently the following species resemble Clanothruz fusca:

Clonchriz tenus Kolkwitz. (Kolkwitz, Schizomycetes in Kryptogamenflora der Mark Brandenburg, 5, 1915, 141, Crenothriz tenuis Dorff, Die Disenorganismen, Pflannenforschung, Hett 16, 1931, 42) From the settling bysin of a sewage plant near Berlin. Dorff thinks this may have been a growth form of Crenothriz fusca Dorff

Mycothrix abundans Naumann, (Kungl. Svenska Vetenskapsakad. Handl I, 62, 1921, Part 4, 44.) From the Aneboda region, Sweden. The type soccess of the renus Mycothrix.

Uycothriz clonotricoides Naumann (loc cit., 54). From the Aneboda region, Sweden

## Genue III. Leptothrix Kut:ing.

(hütring, Phycologia Generalis, 1813, 198, not Leptotrichia Trevisan, Reale Ist. Lombardo di Sci. e Lettere, Ser. 2, 12, 1879, 138, Detoniella DeToni and Trevisan, in

Saccardo, Sylloge Fungorum, 6, 1889, 929; Chlamydothrix Migula, Syst. d. Bakt., 2, 1900. 1030; Conidiothriz Benecke, Bau u. Leben d. Bakt., 1912, 489; Megalothriz Schwers, Cent. f. Bakt., H Abt., 35, 1912, 273; Syncrotis Enderlein, Sitzber. Gesell. Naturf. Freunde, Berlin, 1917, 312.) From Greek leptos, small and threx, hair,

Filaments of cylindrical colorless cells, with a sheath at first thin and colorless. later thicker, yellow or brown, encrusted with ferric hydrovide. The oxide may be dissolved by dilute acid, whereupon the inner cells show up well. Multiplication is by division and abstraction of cells and by motile cylindrical swarmers. False branching may occur.

The type species is Leptothrix ochracea Kützing.

# Key to the species of genus Leptothrix.

- I. Filaments not spirally twisted.
  - A. Free swimming, not attached. 1. Sheath homogeneous, cylindrical,

    - 1. Leptothrix ochracea. 2. Sheath composed of a bundle of fine parallel filaments.
    - 2. Leptothriz trichogenes.
  - B. Attached to a substrate by a holdfast.
    - 1. Arising singly, each filament from its own holdfast.
      - a. Filaments show false branching. 3. Leptothriz discophora.
      - aa. Filaments unbranched.
        - 4. Leptothrix sideropous.
    - 2. Numerous filaments arising from a common holdfast.
      - a. Filaments large, uniform in diameter.
      - 5. Leptothrix lopholeg. aa. Filaments smaller, tapering toward the tip.
      - 6. Leptothriz echinata.
- II. Filaments spirally twisted.
  - A. Epiphytic, growing twisted around filamentous algae.
    - 7. Leptothriz epiphytica.
  - B. Not epiphytic.
- 8. Lepiothrix pseudovacuolata.

ochracea Kützing. 1. Leptothrix (Kntzing, Phycologia Generalis, 1843, 198; Lyngbya ochracea Thuret, Ann. Sci. Nat. Bot., VI, 1, 1875, 279; Beggiatoa ochracea Gasperini, Ann. d'Igiene Sper., 2, 1912, 000; Chlamydothrix ochracea Migula, Syst. d. Bakt , 2, 1900, 1031.) From Latin ochra, yellow.

Long filaments, free-floating, never attached to a substrate, never branching. Filaments 1 micron in thickness, composed of rod-like colorless cells, surrounded in young filaments by a delicate sheath which later becomes yellow to brown in color.

Sheath homogeneous, completely dissolving in dilute hydrochloric acid.

When the sheath becomes very thick, the filaments creep out of the sheath and secrete a new one, so that many empty sheaths are found. Polar flagellate, motile, swarm-cells have been observed

Habitat: Iron-bearing waters.

2. Leptothrix trichogenes Choloday. (Choledny, Cent. f. Bakt., II Abt., 61, 1924, 292; Toxothrix ferruginea Molisch, Die Eisenbakterien in Japan, Sc. Report Tohoku J. Univ., 4 Ser. Biol., 1, 1925,

13.) From Greek thriz, hair and geno, producing.

Long, slender, articulated filaments, free-floating, never branched. Filaments 0 5 micron in thickness, composed of rod-like coloriess cells.

Inlaments surrounded by a fine sheath. This sheath ruptures longitudinally and rolls up as a fine hair-like body at one side of the filament. This process continually repeated leads to the development of a thick sheath composed of numerous hair-like bodies arranged in parallel bundles, which are easily separated from the filament. The sheath is completely dissolved in dilute hydrochlore acid.

Mode of reproduction is unknown. Habitat: Iron-bearing waters.

3 Leptothriz discephora (Schwen)
Dorff. (Megalothriz discephora Schwens,
Cent f. Bikt., II Abt., 33, 1912, 273;
Leptothriz crassa Cholodny, Cent. f.
Bikt., II Abt., 61, 1921, 292; Chlamydothriz discophora Naumahn, Ber. d.
Deutsch Bot. Ges., 48, 1928, 141; Dorff,
Die Tisenorgunismen, Pflungenforschung, Heft 16, 1931, 31.) From Latin
Ingest, disk and Greek phorous, to bert.

Long, slender, articulated filaments composed of elements of varying length showing false branching (Cholodny, loc cit, 297) Usually attached to a submerged substrate but may be free-floating

l'itaments surrounded by a heavy sheath, thick (10 to 15 microns) at the base, tapering toward the free tip, heavily impregnated with ferric hydroxide

Reproduction by motile swarm cells liberated from the tip, and also by the emergence of the filament from the sheath, with subsequent breaking up into individual non-motile cells (condrs).

Habitat. Water.

4 Leptothrix sideropous (Molisch) Cholodny (Cilamylothriz sideropous Molisch, Die Eisenbakterien, 1910, 14; Gallionella sideropous Naumann, Kungl. Svenska Vetenskapsakad, 62, 1021, 33; Cholodny, Die Eisenbakterien, Pflanzenforschung, Heft 4, 1926, 25.) From Greck sideros, iron.

Short, unbranched filaments composed of rod shaped cells of varying length, 0.6 micron in diameter.

Sheath very thin, colorless, giving an iron reaction only at the base of the filament. Attached by a broad holdfast which gives a marked iron reaction.

Habitat: Found in water, growing on submerged surfaces.

5 Leptothrix lopholea Dorff. (Die Lisenorganismen, Pfanzenforschung, Heft 16, 1934, 33.) From Greek lophos, erest, tuft.

Short, slender unbranched filaments, uniform-in diameter, attached to a substrate, 5 to 13 filaments arising from a common holdfast. Filaments 20 to 33 microns long, cells 0 5 by 1.0 to 1.3 microns.

Sheaths composed of ferric hydroxide dissolve completely in dilute hydrochloric acid.

Filaments creep out of the sheath as in Leptothriz ochracea. Habitat: Water.

 Leptothrix echinata Beger. (Cent. I. Bakt., II Abt., 52, 1935, 401.) From Latin echinatus, bristled.

Similar to the preceding species, but occurring in larger colonies, 20 to 50 filaments arising from a common hold-fast. Filaments are shorter (9 to 10 microns).

Sheath is thicker at the base and tapers toward the free tip of the filaments, which are slightly spiral. The sheath contains an organic matrix visible after treatment in dilute hydrochloric acid.

Habitat: Found in water, especially in manganese-bearing waters.

7. Leptothriz epiphytica (Migula) Chester. (Streptothriz epiphytica Migula, in Engler and Prantl, Die naturl. Pflanzenfam., f., la, 1895, 38; Lyngbya epiphytica Hieronymus, in Kirchner, ibid., 67; Chester, Manual Determ. Bact., 1901, 370; Leptothrix volubilis Cholodny, Cent. I. Bakt., II Abt., 67, 1924, 292; Chlamydothrix epiphytica Naumana, Ber d Deutsch. Bot. Ges., 46, 1928, 141.) From M.L. epiphyticus, epiphytic.

Long cylindrical unbranched filaments growing spirally around filaments of Tolypothrix, Oedogonium, etc. Cells rod-shaped, 1 by 2 microns.

Sheaths cylindrical, encrusted with

Cells may leave the sheaths as in Leptothrix ochracea

Habitat: Water.

Leptothrix pseudovacuolata (Perfiliev) Dorff. (Spirothriz pseudovacuolata Perfiliev, Verh. d. Int. Verein. f. theor. u. angew. Limnologie, 1925, Stuttgart, 1927; Dorff, Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 36.) From Greck, having false vaeuoles.

Filaments 85 to 250 microns in length, unbranched, spirally wound, occasionally straight. Strongly encrusted with ferric hydroxide Spirals 20 to 24 microns from crest to crest

crons from crest to crest Cells rounded at the ends, thin-walled, granular, 1 7 to 2 8 by 3.5 to 30 microns Apparently beterotrophic

Habitat Found in bottom muds of deep lakes with very low oxygen content.

Appendix: The following simple, filamentous organisms have also been placed in the genus Leptothrix or appear to belong here.

Chlamydothrix thermalis Molisch (Die Eisenbakterien in Japan. Sc. Report Tohoku J Univ., 4 Ser Biol., 1, 1923, 135; Leptothrix thermalis Dorff, Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 38) From hot springs in Japan.

Leptothrix hyalina (Migula) Bergey et al. (Streptothrix hyalina Migula, in Engler and Prantl, Die naturl. Pflanzenfam., 1, 1a, 1895, 38; Chlamydothrix hyalina Migula, Syst. d. Bakt., 2, 1900, 1003; Bergey et al., Manual, 1st ed., 1923, 391) Prom swamp water.

Leptothrix major Dorff. (Die Eisenorganismen, Pflanzenforschung, Heft 16, 1934, 35.) From Spree River water near Berlin.

Leptothrix winogradskii Cataldi (Thesis, Univ. Buenos Aires, 1939, 61) From water.

Lieskeella bifda Perfiliev. (Perfiliev, Verh. d., internat. Vereinigung f., theoret. u. angew. Limnologie, 1925, Stuttgart, 1927; quoted from Dorff, Die Eisenorganismen. Pflancenforschung, Helt 16, 1934, 27; also designated Liesteella bifilaris by Perfiliev.) From iron bearing water. Shows gilding movements similar to blue-green algae. The type species of the genus Lieskeella Perfilev.

Sideromyces glomerata Naumann. (Quoted from Dorff, Die Eisenorganismen, Pflanzenforschungen, Heft 16, 1934, 27.) From swamps in the Aneboda region of Sweden. This is the type species of the genus Sideromyces syn. Mycogallonella Naumann.

Sphaerathriz latens Perfiliev. (Perfiliev, Verh. d. internat. Vereinigung f. theoret. u. angow. Limnologie, 1925, Stattigart, 1927; quoted from Dorft, Discenterganismen. Pfansenforschung, Heft 16, 1934, 29) From a peat bog in a small pond near Leningrad. This the type species of the genus Sphaerothriz Perfiliev. Grows in disks showing a concentric structure.

#### PAMILY II CRENOTHRICHACEAE HANSGIRG \*

(Österr. Bot. Ztschr., 36, 1888, 228.)

Filaments not branched, attached to a firm substrate, showing differentiation of base and tip. Sheaths plainly visible, thin and colorless at the tip, thick and encrusted with iron at the base. Cells cylindrical to spherical, dividing in three planes to produce the spherical non-motific condition.

#### Genus I. Crenothrix Cohn.

(Cohn, Beitr. z. Biol d. Pflanz., 1, Heft 1, 1870, 108; Phragmidiothriz Engler, Verh. Bot. Ver. Brandenb., 24, 1882, 19 ) From Greek crenos, spring and thriz, hair. Characters as for the family.

The type species is Crenothriz polyspora Cohn.

 Crenothriz polyspora Cohn (Bettr z Biol d. Pflanz, I, Heft 1, 1870, 108; Hyphcolhriz kuchniana Rabenhorst, Tlora europ algarum, Sect. II, 88; Leptothriz kuchniana Rabenhorst, Algen Sachsens, No 281, Crenothriz kuchniana Zopi, Zur Morphologie der Spaltpilzen, 1882, 36, Crenothriz manganifera Jackson, Ilyg Rund, 14, 1901, 19) From Greek, many spores.

Long, articulated filaments, unbranched, enclosed in a sheath which becomes expanded toward the tip. The sheath is composed of organic matter encrusted with iron. Plaments, including the sheath, measure 2 to 9 micross in diameter.

Vegetative cells vary markedly in length from long cylindrical to short evoid forms

Conidia, spherical, 1 to 2 microns in diameter, are liberated from the expanded tips of the sheaths. They are non-motile

Cultivation Has not been grown on artificial media in pure culture.

artificial media in pure culture.

Conidia may germinate upon the ex-

terior of the sheath from which they have been liberated, giving rise to new filaments attached to the surface of the older one, presenting a simulation of false hranching.

Cholodny Lelieved Clonothriz Jusca to be identical with Cranothriz polyspora. However, Clonothriz Jusca shows genuine false branching and produces conditis by fassion in only one plane, so that the filaments taper toward the tipusted of expanding (see Kolk, Amer. Jour. Bot., 25, 1938, 11) for a clear cut differentiation of these two species.

Source This organism is wide-spread in water pipes, drain pipes and springs where the water contains iron. It frequently fills pipes under such circumstances and causes a real nuisance. Found by Cohn in samples of water from springs in the neighborhood of Breslau, Germany.

Habitat In stagmant and running waters containing organic matter and iron salts, growing as thick brownish or greenish masses.

Completely revised by Prof. A. T. Henrici, University of Minnesota, Minneapolis, Minnesota, December, 1938, further revision by Prof. Robert S Breed, New York State Experiment Station Geneva, New York, July, 1946.

# FAMILY III. BEGGIATOACEAE MIGULA.\*

(Arb. Bakt. Inst. Karlsruhe, 1, 1894, 238; in part, Leuco-Thiobacteria Bavendamm, Die farblosen and roten Schwefelbakterien, Pflanzenforschung, Heft 2, 1924, 102.)

Filamentous organisms, composed of chains of cells. Individual cells generally not visible without staining. Structure very similar to that of Oscillatoracceae, but devoid of chlorophyll and phycocyanin. When growing in the presence of hydrogen sulfade, the filaments contain sulfur globules. Special reproductive structures unknown.

In proposing the family Deggiatoaccae for the two genera of this subgroup known in 1894, Migula remarked that "it would be best to combine them with the Oscillatoriaccae and classify them among the Schizophyta" (Arb. Dakt. Inst. Karlsruhe, f. 1894, 238). The same authority has stated: "Also in view of their internal structure the species of Beggiatoa are so similar to those in the genus Oscillaria that they can hardly be separated generically" (in Engler and Pranti, Die naturi. Pfianzenfam., 1, 1a, 1895, 41).

Since then, the close relationship between the filamentous, colorless sulfur bacteria

toaceae Migula is retained for these filamentous sulfur bacteria. Taxonomicany they could readily be classified as colorless members of the class Schizophyceae.

## Key to the genera of family Beggiatoaceae.

- I. Filaments non-motile. Grow attached by means of holdfast at base. Genus I. Thiothriz, p. 988.
- Filaments motile, like Oscillatoria, by creeping or sliding movements along a solid substrate. Not attached.
  - A. Occurring singly, not embedded in a common slime-sheath.
    - Filaments straight or bent, but not permanently rolled.
       Genus II. Beggiatog, p. 990.
    - 2. Filaments coiled or spirally wound.

Genus III. Thinspirillopsis, p. 993.

B. Occurring in bundles, embedded in a common stime-sheath.

Genus IV. Thioploca, p. 993.

# Genus 1. Thiothrix Winogradsky.

(Beitr. z. Morph. u. Physiel. d. Bakt., I, Schweselbacterien, Leipsig, 1888,

29.) From Greek theion, sulfur, and thrix, bair.

Filaments non-motile, segmented, with a delicate sheath, and differentiated into base and tip. Grow attached at base to solid objects by means of gelatinous hold-fast. Reproduction by transverse fission of the segments, and by rod-shaped so-called conidia, probably arising by the apical segments becoming free. Temporarily, the conidia show creeping motility, settle on solid objects, and grow out into new filaments.

The type species is Thiethrix mies (Rabenhorst) Winogradsky.
The following key to the species of the genus Thiethriz is based upon the diameter

Completely revised by Prof. C B. Van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

of the filaments and their habitat, the only criteria used by previous authors for the differentiation of the seven published species. The validity of these distinguishing characteristics is, however, doubtful because their constancy has not been sufficiently established; so far the morphology of the Thothriz species has not been studied in bure cultures.

#### Key to the species of genus Thiothrix.

- I Found in fresh water environments.
  - Λ Diameter of filaments about 2 (1.4 to 3 0) microns.
    1 Thiothrix pirca.
  - B. Diameter of filaments about 1 micron.
  - 2. Thiothriz tenuis.
    C Diameter of filaments less than 0.5 micron.
- 3. Thiothrix tenuissima
- II I'ound in marine environments
- II Joung in marine environment
  - A Diameter of filaments averages about 20 microps (actual range 15 to 30 mierons)

    4. Thiothriz toulit
    - 4. I RIGIAFIX TOURI
  - B Diameter of filaments about 4 (4 4 to 6 6) microns. Segments about 25 microns long
    - 5 Thiothrix longiarticulata.
  - C. Diameter of filaments about 3 (1.8 to 5) microns. Segments about 1 micron long.
    - 6. Thiothriz annulata
  - D Diameter of filaments about 1 (0 8 to 1.3) micron,
    - 7. Thiothysz marsna.

1 Thiothrix nives (Rabenhorst, Winogradsky (Begyndoa nives Rabenhorst, Ilora europaea algarum, 2, 1865, 91; Leptotrehia nives De Toni and Trevisan, in Saccardo, Sylloge Fungorum, 8, 1899, 931, Symphyothriz nives Wartman and Schenk, Schwitz, Kryptogramenflora; Winogradsky, Bettr. z. Morph. u. Physiol d Bact., I, Schwefelbacterien, 1888, 39) Prom Latin niverus snowy.

Filaments with a thus sheath, diameter 20 to 30 microns at base, 1.7 microns in the moddle, 1.4 to 1.5 microns at tip As long as the filaments contain sulfur globules, segmentation is invisible; length of segments 4 to 15 microns, the longer ones usually marapers, the shorter ones usually marapers, the shorter ones near base.

Motile segments (so-called conidia) mostly single, 8 to 15 microns long, sometimes in short filaments of 2 to 4 cells and up to 40 microns long. These segments may settle and develop near the

base of the mother filament or on a filament stelf, forming verticillate structures. These have been described as Thiothriz area var certicillata Myoshi (Jour. Coll. Szi., Imp. Univ. Tokyo, 10, 1897, 155).

Habitat: Fresh water environments where hydrogen sulfide is present (sulfur springs, stagment pools, on submerged decaying regetation, etc.).

 Thiothrix tenuls Winogradsky. (Regrators alba var. underrides Engly, Ub die Pdz-Vegetation des weissen oder todten Grundes in der Rieber Bincht, 1883, 4, Winogradsky, Bilt z Morph, u. Physiol. d Bret., I. Schwefelbraterien, 1888, 49) From Latin fenuls, alender.

Filaments about 10 micron in diameter, of nearly uniform thickness. Often in dense, felted masses. Segments 4 to 5 microns long.

Habitat: Presh water environments

where hydrogen sulfide occurs. According to Bavendamm (Die farblosen u. roten Schwefelbakt., Pflanzenforschung, Heft 2, 1924, 107) also found in sea water.

 Thiothrix tenuissima Winogradsky. (Beitr. z. Morph. u. Physiol. d. Bact., I. Schwefelbacterien, 1883. 40; Thiothrix minutissima Uphof, Arch. f. Hydrobiol., 18, 1927, 77.) From Latin tenuis, diminutive, very slender.

Filaments less than 0.5 micron in diameter, usually in dense masses.

Habitat: Fresh water environments where hydrogen sulfide occurs.

 Thiothrix voukli Klas. (Arch. f. Protistenk., 88, 1936, 123.) Named for Vouk, a Russian scientist.

Filaments 15 to 30, most frequently 17 microns in diameter, of rather uniform thickness. Segments visible uithout special treatment. Segments generally somewhat longer than wide, rarely square, occasionally barrel-shaped. Length of segments 15 to 30, mostly 19 to 23 microns. Motile segments not yet observed

Apart from the lack of motility, this species closely resembles the motile Beggiatoa mirabilis.

Source Found in effluent of sulfur springs at seashore near Split, Jugoslavia. So far reported only once.

Habitat Marine environments containing hydrogen sulfide

5 Thiothrix longiarticulata Klas (Arch f. Protistenk, 88, 1936, 126) From Latin longus, long and articulatus, iointed.

Filaments 3 3 to 6 6, most frequently 4 2 microns in diameter, of uniform thickness Occur in dense, felted masses. Segments long, measuring 19 to 33, mostly 26 microns in length. Sulfur droplets usually absent in the proximity of cross-walls. Motile segments not yet reported.

Source: Found in effluent of sulfur springs at seashore near Split, Jugoslavia. So far reported only once.

Habitat: Marine environments containing hydrogen sulfide.

 Thiothrix annulata Molisch. (Cent f. Bakt., II Abt., 55, 1912, 58.) From Latin annulatus, ringed.

Flaments 3 to 4, occasionally up to 5microns in diameter, thinner at base (2 microns) and at tip (1.8 microns). Segments only about 1 micron in length. Often found with narrow bands which are free of sulfur, thus giving a ringed appearance to the filaments. Old filaments may show spacial thickening and distortion, but this is not characteristic for the species.

Habitat: Marine environments containing hydrogen sulfide; frequently on decaying algae.

7. Thiothrix marina Molisch. (Cent. f. Bakt., II Abt., 53, 1912, 58) From

Latin marinus, pertaining to the sea. Filaments about 1 (0 8 to 1.3) micron in diameter, of rather uniform thickness. Usually in felted masses

Resembles Thiothriz tenuis Since the latter has been reported from marine environments (Bavendamm, Die farblosen u. roten Schwefelbakteriea, Pflanzenforschung, Heft 2, 1924, 197). Thiothriz marina may not be an independent species, but identical with Thiothriz tenuis.

Habitat: Marine (?) environments containing hydrogen sulfide; frequently on decaying algae.

# Genus II. Beggiatoa Trevisan.

(Prospetto della Flora Euganea, 1842, 56.) Named for the Vicenza physician, F S. Beggiato.

Filamentous, mottle, segmented organisms, occurring singly or in white to creamy felted masses in which the separate filaments retain their individuality. Not at-

tached. Existence of a sheath not definitely established. Movements of the filaments dependent upon a solid substratum over which they slide in the name manner as species of Oscillatoria. Sliding movements often accompanied by rotation of filaments around long axis Reproduction by transverse fission of segments; the filaments may also break up into smaller units, each continuing a separate existence. The latter mode of multiplication corresponds to that by means of the so-called motile confide or regments in Thiothriz.

The type species is Beggiatoa alba (Vaucher) Trevisan,

In this genus, also, the species so far described are differentiated on the basis of dimensions. The range of sizes for separate species appears, in most cases, quite arbitrary, especially in view of the existence of practically all intermediate stages. Since the smaller forms have been found both in fresh water and marine environments (Bavendamm, Die farblosen u roten Schwefelbakteren, Pflanzenforschung, Heft 2, 1921, 101), the previously described Regnatoa marina has been omitted as a separate species. Pure culture studies may establish more staisfactory methods of differentiation and a better understanding of snecision.

### Key to the species of genus Begglatoa.

- I Diameter of filaments greater than 25 microns.
  - 1 Beggiatoa gigantea
- II Diameter of filaments less than 25 microns
  A. Diameter of filaments greater than 15 microns
  - A. Diameter of filaments greater than 15 microns

    2. Reagiatoa mirabilis
  - B Diameter of filaments less than 15 microns.
    - 1 Diameter of filaments greater than 5 microns
      3 Beggiaton grachhoodea
    - 3 Beggialou gracknoidea
      2. Diameter of filaments less than 5 microns.
    - 2. Diameter of filaments jess than 5 microns.
      a Diameter of filaments greater than 2.5 microns
      4. Reggiatoa ulba.
      - as Diameter of filaments less than 2 5 microns.
        - b Diameter of filaments greater than 1 micron
          5 Beggiatog leptomitiformis
        - bb Diameter of filaments less than 1 micron.

          6 Reggiatoa minima

1 Beggiatoa gigantea Klas. (Arch f ment Mikrohot , 8, 1937, 318, includes the ment arge forms of Beggiatoa mirabilis Cohn. Term

Hedwigia, 4, 1865, 81) From Greek

Filaments 26 4 to 55, average 35 to 40 microns in diameter. Kivs, in his diva mosts, gives 26 to 429 microna-sadiments on This would exclude the largest forms of Beggiaton mirability described by Hinze (Ber d., deut., bot. Ges. 19, 1201, 369). Since the proposal of a separate species for such organisms appears at present unjustified, the maximum diameter laws for been increased. His-

ments clearly segmented, length of segments 5 to 13, average 85 microns. Terminal cells rounded or tapering.

When the filaments are in healthy condition they are of uniform width; bulging of the sides indicates unfavorable conditions

Habitat Apparently restricted to manue controlments containing hydrogen sulfide. Prequent on decaying marine algae.

2 Beggistos mirabilis Colin enend blas (Colin, Hednigia, 4, 1935, 51; Klas, Arch. f. Mikrobiol., 8, 1937, 318.) From Latin mirabilis, wonderful,

Filaments 15 to 21.5, average 17 microns in diameter. The so-defined species does not overlap with Beggiatos gigantea necording to Klas (loc. cit.). Segmentation usually observable without special treatment; segments 5 to 13, average 5.5 microns long. Terminal cells rounded or tapering, sometimes bent.

When the filaments are in healthy condition they are of uniform width; an unfavorable environment induces bulging of the sides.

Habitat: Apparently restricted to marine environments containing hydrogen sulfide. Common on decaying marine algae.

Uphof (Arch. f. Hydrobiol., 18, 1927, 83) has created a species, Beggiatos maxima, which on account of its diameter (10 to 20 microns) falls partly within the range of Beggiatos mirabilis, partly within Beggiatos arachnoides. Since it was found in a fresh water environment, the habitat of Beggiatos mirabilis may not be restricted to maxine media.

3 Beggiatoa arachnoldea (Agardb) Rabenhorst, (Oscillatoria arachnoidea Agardh, Regensburger Flora, 1827, 634; Rabenhorst, Flora europaea algarum. 1865, 91, Beggiatoa pellucida Cohn, Hedwigia, 4, 1865, 82; ? Oscillatoria beogiatoides Arzichonsky, Bull Jard. Imp. Bat., St Pétersb , 2, 1902, 38, 47; includes the larger members of Beggiatoa major. Winogradsky, Beitr. z. Morph. u. Physiol. d Bact , I, Schwefelbacterien, 1889, 25; and the smaller ones of Reggiator maxima Uphof, Arch f. Hydrobiol., 18, 1927, 80.) From Greek, resembling a cobweb.

Filaments 5 to 14 microns in diameter. Segmentation generally observable only after special staining or removal of sulfur globules; segments 5 to 7 microns in length. Terminal cells rounded, often tapering. Filaments of uniform width.

Habitat: Both fresh water and marine environments containing hydrogen sulfide.

 Begglatoa alba (Vaucher) Trevisan. (Oscillatoria alba Vaucher, Histoire des Conferres d'eau douc, 1803, 198; Beggiatoa punctata Trevisan, Prospetto della Flora Euganea, 1842, 56; Beggiatoa alba var. marina Cohn, Hedwigia, 4, 1865, 83; Beggiatoa marina Molisch, Cent. f. Baht., II Abt., 52, 1912, 55; in part, Beggiatoa major Winogradsky, Beitr. z. Morph. u. Physiol. d. Bact., I, Schwefelbacterien, 1888, 25.) From Latin albaz, white.

This is the type species of the genus. Filaments 2.5 to 5, most commonly 3 microns in diameter, of even width. Segmentation difficult to detect in filaments containing many sulfur globules; segments 3 to 9 microns long, shortly after division practically square. Terminal cells rounded.

Habitat: Both fresh water and manne environments containing hydrogen sulfide.

Distribution: Ubiquitous, and probably the most common of the filamentous sulfur bacteria.

5. Beggiatoa leptomitiformis (Meneghini) Trevisan. (Oscillatoria leptomitiformis Meneghini, Delle Alghe vicenti nelle terme Eugance, 1844, 122; Trevisan, Prospetto della Flora Euganca, 1842, 55; Beggiatoa media Winogradsky, Beitr. z. Morph. u Physiol. d. Bact., I, Schwefelbacterien, 1888, 25.) From Greek leptos, small and mutos, thread and Latin forma, shape.

Filaments 1 to 2.5 microns in diameter, of uniform width. Szgmentation only observable after removal of sulfur globules; segments 4 to 8 microns in length. Terminal cells usually rounded.

Habitat. Fresh water and marine environments containing hydrogen sulfide. Beggiatoa minima Winogradsky.
 Worph. u. Physiol. d. Baeterien, I. Schwefelbacterien, 1888, 28, Beggiatoa minor Uphof, Arch. f. Hydrobiol., 18, 1927, 79; not Beggiatoa minima Warming, Om Nogle ved Danmarka Kyster levende Bakterier, 1876, 52, which from the desemption is

not a Beggiatoa.) From Latin mini-

Filaments less than I micron in diameter, of uniform width. Normally appears unsegmented; length of segments about I micron

Habitat. Fresh water and marine environments containing hydrogen sulfide

#### Genus III. Thiospirillopsis Uphof.

(Arch. f. Hydrobiol., 18, 1927, 81) From Greek theion, sulfur M L. spirillum, spirillum and Greek opsis, appearance.

Filamentous, colorless sulfur bacteria, segmented, and spirally wound. Exhibit creeping motility, combined with rotation, so that the filaments move forward with a carkscrev-like motion. The tips produce oscillating movements. Resembles Spiruling among the Oscillatoriaccae.

The type species is Thiospirillopsis floridana Uphol.

1 Thiospiriliopsis floridana Uphof. (Arch f Hydrobiol., 18, 1927, 83) Named from Tlorida, the place where the first found

Filaments 2 to 3 microns in diameter. Segmentation difficult to observe without special precautions; segments about 3 to 5 microns long. The spiral windings are regular

Source Found in the sulfur spring

water at Wekiwa Springs and Palm Springs, Florida. A very similar orgraism has been observed at Pacific Grove, California, in a manne aquarum where hydrogen sulfide had been genersted by sulfate reduction. The genus Thosprinliposi; may, therefore, be more

where hydrogen solinds had been genersted by sulfate reduction. The genus Thospirillopsis may, therefore, be more wide-spread than is generally believed. Habitat- Probably widely distributed

in water containing sulfur.

# Genus IV. Thioploca Lauterborn

(Ber d. deut botan. Ges , 25, 1907, 238) Name derived from Greek theson, sulfur, and plata, braid

Filaments of Beggatoa-like appearance, but occurring in parallel or braided bundles, enclosed by a common wide sline-sheath. The latter infrequently incrusted on the outside with detritus. Within the sheath the individual filaments are motile in the manner of Beggatoa; the filaments are segmented, the terminal segments often tapering.

Resembles closely the genera Hydrocoleus and Microcoleus among the Oscilla-toriaccae.

It is doubtful whether the members of the group Thioploca are true colorless sulfur betters, most investigators of thee forms have reported a greenish-blue coloration of the filaments. Only the regular occurrance of sulfur droplets in filaments taken from their natural habitat stamps the organisms as sulfur bettern. In view of the close relationship of the Begguatoaccae to the blue-green Oscillatoriaccae, this is, however, a minor issue.

Four species have been described to date. Three correspond, with respect to the individual flurents, to Reguloo arechnoides, Reguloo alba, and Reguloo lepto-nitionary respectively, the fourth appears to be a combination of the first and third.

spéciés di Beggiatoa in a common sheath. This occurrence of two distinct species of Beggiatoa in a common sheath makes the genus a doubtful taxonomic entity. The type species is Thiomloag schmidle! Lauterborn.

# Key to the species of genus Thioploca.

- I. Filaments in a common sheath of fairly uniform diameter.
  - A. Diameter of individual filaments 5 to 9 microns.
    - 1. Thioploca schmidlei.
  - B. Diameter of individual filaments 2 to 5 microns.

    2. Thionica increase
  - C. Diameter of individual filaments 1 to 2 microns.
  - 3. Thioploca minima.
- II. Filaments in common sheath of greatly different diameter.
  - 4. Thioploca mizta.

1. Thioploca schmidlei Lauterborn. (Ber. d. deut. bot. Ges., 25, 1907, 238.) Named for Mr. Schmidle

Individual filaments in a common sheath 5 to 9 microns in diameter, clearly segmented Segments 5 to 8 microns in length. Mucilagnous sheath 50 to 160 microns in diameter. Number of filaments embedded in one sheath variable

ments embedded in one sheath variable Source Various localities in Central Europe.

Habitat. So far reported only in fresh water mud, containing hydrogen sulfide and calcium carbonate.

2 Thioploca ingrica Wislouch (Ber d. deut bot. Ges, 30, 1912, 470) From Ingria, an ancient district of Leningrad.

Individual filaments in common sheath 2 to 45 microns in diameter, clearly segmented. Segments 15 to 8 microns in length. Mucilaginous sheath up to 80 microns in diameter Number of filaments in one sheath variable

Source. Various localities in Central Europe.

Habitat Found in fresh water and marine mud containing hydrogen sulfide

 Thioploca minima Koppe. (Arch. f. Hydrobiol, 14, 1923, 630) From Latin minimus, least

Individual filaments in a common sheath 08 to 15 microns in diameter, segmentation generally observable only after removal of sulfur droplets. Segments I to 2 microns long. Mucilaginous sheath up to 30 microns in diameter. Number of filaments in one sheath variable.

Source: Various localities in Central Europe.

Habitat: Fresh water and marine mud containing hydrogen sulfide.

4. Thioploca mixta Koppe. (Arch. f. Hydrobiol., 14, 1923, 630.) From Latin mixtus. mixed.

Individual filaments in a common sheath of two clearly different sizes, comprising both filaments of 6 to 8 microns, and filaments of about 1 micron in diameter. The former are clearly segmented, with segments of 5 to 8 microns in length. In the latter segmentation is visible after removal of sulfur droplets; segments 1 to 2 microns long. Mucilaginous sheath usually about 50 microns thick. Number of filaments in one sheath variable.

Source Reported so far only from Lake Constanta.

Habitat: Fresh water mud containing

Appendix: In addition to the above genera and species, a number of insufficiently characterized, filamentous sulfur bacteria which may be related to the Beggiatoaceae have been described under

Constitution States (Dansk Botan, Arkiv, 1, 1921, 1)

Filamentous, nonmotile organisms, of uniform width, between 05 and 1 micron in diameter, covered on the outside Segmentation not rewith sulfur ported. The cutstanding characteristic of the genus Condiothriz is the supposed multiplication of the filaments by means of conidia which arise by budding on the filament. Apart from this reported occurrence of a budding process, the description is similar to that of Leptothriz sulphurea and of Thiothrix tenuis and Thinthrix tenuissima. Since consecutive observations on growing organisms are lacking, it seems advisable to consider Conidiothriz sulphurea as probably identical with Thiothrix tenuis or Thiothrix tenuissima

Leptothrix sulphurea Miyoshi (Jour Coll Sci., Imp. Univ. Tokyo, Japan, 10, 1897, 154.)

Filamentous, non-motile organisms, of uniform width, not exceeding 0.7 mieron in diumeter. The filaments are covered on the outside with a powdery deposit of elementary sulfur. Segmentation observable only after special staining; length of regments not published.

I ound by Miyoshi in sulfur aprings in Japan. Although not reported as containing sulfur globules inside the filaments, the description would closely fit Thothris tenus or Thothris tenus as Wingradeky. The latter have been observed in masses covered on the outside with elementary sulfur. Therefore, it seems likely that Leptothris sulphurea is a synonym for Thothris tenus or Thothris tenus or Thothris tenussion.

Thionema raginalum Kulknitz (Ber if dout but Ges, 56, 1938, 11) The type species of the genus

Described as a filamentous, colorless sulfur bacterium, non-motile, attached in the manner of Thiothriz. Tilaments 15 to 2 microns in diameter, segmented. Segments 2 to 5 nicrons long Reproduction, as in the case of Thiothriz, by means of detached secrents.

While this part of the description fits that of Thechtra nrace, the new generic name was proposed on the basis of the occurrence of a destinct sheath, frequently impregnated with iron compounds Sance Winogradsky mentions the occurrence of a sheath also in Thochtra nirca, it seems desirable to consuder Thonema agunatum, at least for the time being, as a probable synonym of Thatter new 100 per 100

Source Found on waterplants in the Teltow-Canal near Berlin, the water containing hydrogen sulfide and iron salts.

Thiosiphon adriaticum Klas. (Sitzungsber. Akad. d. Wissensch. Wien, Mathem.-naturw. Kl. I. 145, 1936, 200)

Described as a filamentous suffur batterium, non-mottle, but without segmentation, heace tubular and uncelliar. Multiplication by means of condita arising from restriction of the apical pirt of the cell. Length of filament about 1 to 15 mm, with 17 to 35 microns, would tapering towards aprev. Condid 13 to 30 microns by 30 to 50 microns by 30 to 50 microns.

The description is at variance with the appearance of the organism in the published photomicrograph in so far as the sare of the counds is voincerned. From the photomicrograph this appears to be about 30 by 200 microns. The entire appearance is strongly reminiscent of that of Beginder merobilis (Beginder appearance is extrained times. The short condita, described in the text, strikingly resemble species of Aetromatium. Consecutive observations on growing cultures of Priorphon do not appear to

have been made. Since (a) the internal structure of the large Beggiatoccae is easily damaged, (b) the segmentation in living individuals is difficult to observe when the filaments are filled with sulfur, (c) the presence of Achromatium in the locality from which Thiosiphon was collected is almost certain, and (d) the developmental cycle is merely a reconstruction of simultaneously observed elements, considerable doubt as to the validity of the genus appears justified.

\* Appendix I: The group of large, unicellular, colorless sulfur bacteria is placed here as a single family, Achromatiaceae Massart as in previous editions of the Manual It includes organisms which are similar in physiology to the Beggiatoaceae.

Massart (Rec. Inst. Bot. Univ. Bruxelles, 5, 1902, 281) proposed the family Achromatiaccae for the bacteria described by Schewiakof (Über einen neuen bacterienahnlichen Organismus des Slaswassers, Habilitationschrift, Heidelberg, 1803) as Achromatium ozaliferum. The family diagnosis was modified by Nadson (Jour. Microbiol.,
St. Pétersb., 1, 1914, 72) and by Nadson and Wislouch (Bull. Princip. Jard. Bot.
Républ. Russe, 22, 1923, 33) to include the genera-Thiophysa and Thiosphaserella.

In this form, the family represents a homogeneous group of organisms, all characterized by a pronounced similarity in cell-shape, structure, method of reproduction and motility. They exhibit very slow, jerky and rotating movements, but are devoid of flagella or other visible organs of locomotion. They closely resemble the blue-creen along of the genus Sunschooccus, even in size.

By including the genus Thiospira in the family Achromatiaceae, Buchanan (Jour. Bact., 3, 1918, 462) modified the diagnosis to read:

Unicellular, large, motile (by means of flagella?). Cells containing granules of sulfur (or in one form possibly exalate) but no bacteriopurpurin.

Thus was proposed a family in which the spiral sulfur bacteria, indubitably related to species of Spirillum among the Eubacteriales, were linked with the taxonomically obscure species included in Achromatium and Thiophysa. Four genera, Achromatium, Thiophysa, Thiospira and Hillhousia were recognized.

Rayandamm (Die farblosen und roten Schwefelbakterien, Pflanzenforschung,

Cells free, motile. As he realized that Hillheusia enound be regarded as a of Achromatium and added the genus Thiovalum Hinze (Ber. d. deut. bot. Ges., 31, 1913, 195), four genera were again included in the family. Thiosphaerella was added as an appendix to Thiophysa.

as an appendix of Individual similar to Achromatium, Thiophysa, and Thiophysically with respect to cell size and structure, but differs conspicuously in being actively and rapidly motile. The manner of locomotion suggests the presence of polarly inserted flagella. However, these have never been demonstrated convincingly.

While it is conceivable that a relationship exists between Thiorulum and the organisms of the Achromatium type, the combination of the representatives into one family should be regarded as tentative and open to question. There certainly is no justification at present for including the sulfur spirills in this lamily. These are placed in this edition of the Manual in Spirilleas among the Eubacteriales.

Completely revised by Prof. C. B. Van Niel, Hopkins Marine Station, Pacific Grove, California, January, 1944.

### FAMILY A. ACHROMATIACEAE MASSART.

(Rec. Inst Bot. Univ Bruxelles, 5, 1902, 251.)

Cells large, spherical to ovoid in shape, sometimes rod-shaped, may contain globules of sulfur and/or calcium carbonate crystals. Do not possess photosynthetic nigments. Fresh water and marine forms.

A satisfactory differentiation of the genera Achromatium, Thiophysa, and Thio-

single genus, Achromatium.

Achromatium mobile Lauterborn (Verhandi Natur-histor.-Mediz. Vereins Heidelberg, N T., 13, 1915, 413) is fundamentally different from the other members of the genus. It possesses a clearly visible polar flagellum, suggesting its close affinity with the Pseudomonadaceae among the Eubocterialies. Whether it is a true sulfur bacterium has not been established with certainty; this appears very doubtful in the case of the two similar forms desembed as Pseudomonas bypunctata and Pseudomonas hyalina by Gieklhorn (Cent f Bakt, II Abt, 50, 1920, 425, 426). Utermöhl and Kreppe (Verhandi. Intern Ver f theoret. u. angew. Linnologie, 1913, 86 and Archivf Hydrobiol., Suppl Bd 5, 1925, 231) have proposed the generic name Macromonas for this group. This has been adopted here.

All of the above mentioned organisms have so far been studied evclusively as found in their natural habitats. Pure culture studies are greatly needed. These may show that the peculiar calcium exhotate inclusions (not calcium oxaltie as thought by Schewiakoff, nor calcium thiosulfate as believed by Hannevart) in Ackromatium oxaliferum and in Macromonas bipunctata occur only under special environmental conditions.

#### Key to the genera of family Achromatiaceae.

- Large, ovoid to spherical organisms, normally containing sulfur globules when found in the presence of hydrogen sulfide.
  - A Non-mottle, or slowly, jerkily sliding across the substrate, Genus I. Achromatium, p. 997.

B Actively motile, independent of the substrate.

Genus II. Thiorulum, p. 999

Il Red theped and curved organisms, motile by means of polar flagella.

A Bean-sheped to short red-shaped organistrs which may contain small sulfur globules, but are chefly characterized by Jarge, round spherules of calcium carbonate as cell inclusions. The polar flagellum is often visible in the larger forms without special stanning

Genus III Macromonas, p. 1000.

## Genut I Achromatium Scheurakoff.

(Schewinkoff, Ub. einen neuen beiterienskinlichen Organismus des Süsswassers, Habbitatuerzehr, Heidelberg, 1893, Modderula Franci, Biel Centralli, 17, 1897, 601, Hilliowna West and Griffiths, Prec. Roy. Sec., B. 81, 1997, 389). From Greek a. without and chroma, color

Thiophysa Hinze (Ber. d. deut. bot. Ges., 21, 1903, 390) and Thiophaceella Nadson (Jour. Microbiel., St. 1 (temb., 1, 1914, 72) are also included in the genus as defined here.

Unicellular organisms with large cells, shortly cylindrical with hemispherical extremities, also ellipseidal to splenical. Cells divide by a constriction in the

middle. Movements, if any, are of a slow, rolling, jerky type and are dependent upon the presence of a substrate. No special organs of locomotion are known. In their natural habitat, the cells contain sulfur droplets and sometimes additional inclusions, such as large spherules of calcium carbonate.

The type species is Achromatium ozaliferum Schewiakoff.

It is not easy as yet to determine whether several species should be recognized in this genus. There appears to be some justification for differentiating between the forms which contain the characteristic and conspicuous calcium carbonate inclusions and forms in which these large spherules are facking. The former have been reported mostly from fresh or brackish water environments, while the characteristic habitat of the latter seems to be marine. It is, of course, probable that the internal deposition of calcium carbonate depends upon the composition of the environment, so that the distinction may prove arbitrary and non-specific.

Achromatum cells of widely different sizes have been described. Schewiakoff (Ub. einen neuen bacterienahnlichen Organismus des Susswassers, Habilitationsschrift, Heidelberg, 1893) mentions a variation of 15 to 43 microns in length, and 9 to
22 microns in width for Achromatium ozaliferum. Larger cells have been observed
by Warming (Videnskab. Meddel. naturbistor. Foren., Kjöbenhavn, 1875, No. 20-28,
380, size to 85 microns), and by Virieux (Ann. Sci. Natur., Ser. 9, 18, 1913, 265; size
to 85 microns in length).

Nadson (Bull Jard Imp. Botan., St. Pétersb., 13, 1913, 106; Jour. Microb., St. Pétersb., 1, 1914, 52) proposed the name Achromatum gigas for the larger organisms. also West and Griffiths (Ann. Bot., 27, 1913, 83) created two species, Hillboura mirabilts, with sizes of 42 to 86 microns long by 20 to 33 microns wide, and Hillbouria palustres, measuring on the average 14 by 25 microns, for the same group of sulfur heateria.

However, Bersa (Sitzungsber, Akad. Wiss., Wien, Mathem.-naturw. Kl., I. 129, 1920, 233) observed so many intermediate sizes that he recognized only a single species. Nadson and Wislouch (Bull. Prine. Jard. Botan., Républ. Russe, £2, 1923, Suppl. 1, 33) arrived at the same conclusion, and this view is accepted here.

The marine Achromatium types which do not contain calcium carbonate crystals, also have been segregated into species on the basis of their size. Here again, there does not seem to be any valid reason for maintaining several species as there is a continuous series of intermediate forms.

Thus, the organisms previously described as Achromatium oxaliferum, Achromatium grgas, Hillhousia mirabilis and Hillhousia palustris are provisionally treated here as one species, while the marine counterpart, Thiophysa volutans, is combined with Thiophysa macrophysa and Thiosphaceella amylifera, all three being regarded as Achromatium volutans

Key to the species of genus Achromatium.

.... in the form

muds.

Į. .

1. Achromatium oxaliferum.

Organisms naturally occurring without such calcium carbonate inclusions.
 Found in marine mud.

2. Achromatium volutans.

Achromatium orallierum Schewiakofi. (Schewiakofi, Üb. einen neuen
bacternenalmilichen Organismus des Süsswassers. Habilitationsschrift, Heidelberg, 1893, Modderula hartugi Frenzel,
Biol. Centralbl., 17, 1897, 801; Hillhousen
mirabilit West and Griffiths, Proc Roy.
Soc., B, 81, 1990, 389. Hillhousen palustris West and Griffiths, Ann Bot., 27,
1913, 83, Achromatium gugas Nadson,
Bull. Jard. Imp. Bot., St. Pétersb., 18,
1913, 100) From Latin oralis, intended
to refer to the supposed presence of
gwilst erystells and Ieru. to best

Unicellular organisms, varying in shape from spherical or ovoid to shortly cylindrical with hemispherical extremties. Division by constriction in the middle. Cells vary in size from spheres of about 7 microns or even less in diameter to giant forms 100 microns long by 35 microns wide. The extremes are connected by a continuous series of intermediate size.

Organisms may show motility of a jerky and rotating kind, always very slow, and dependent upon a substrate Typical organs of locomotion absent

Normally contain small sulfur globules, accompanied by much larger calcium carbonate crystals, the latter in the form of large highly refractile spherules. Under favorable environmental conditions these may disappear before the sulfur globules. Cells with calcium exbonate inclusions have a very high specific gravity. They are, therefore, found only in the bottom of pools, streams, etc., usually in the mud.

Strictly microserophilic, and appar-

Habitat: Fresh water and brackish mud containing hydrogen sulfide and calcium salts According to Nadson and Wislouch (Bull princip Jard. bot., Républ. Russe, 22, 1923, Suppl. 1, 33) also in ma-

2 Achromatium volutans (Hinne) comb. nor. (Thiophysa rolutans Hinne, Ber. d. deut bot. Ges. £1, 1903, 309; Thiophysa macrophysa Nadson, Bull. Jard. Imp. Bot., St. Pétersb. £5, 1913, 106 and Jour. Microb., St. Pétersb. £1, 1914, 51; Thiosphacetlla amyldren Nadson, Bull. Jard. Imp. Bot., St. Pétersb. £5, 1913, 106 and Jour. Microb., St. Pétersb. £1, 1914, 51.) From Latin tolutans. rollin tolutans.

Unicellular organisms, spherical to ovoid in shape, dividing by constriction in the middle. Size variable, ranging from spheres about 5 microns in diameter to ovoids up to 40 microns in length.

Cells may show motility of a jerky and rotating kind, always very slow, and dependent upon a substrate. Typical organs of locomotion absent.

Normally contain sulfur globules, but lack large internal calcium carbonate deposits

Microaerophilie, apparently requiring hydrogen sulfide

Habitat Marine mud containing hydrogen sulfide, decaying seaseeds

#### Genus II Thiovulum Henze

(Ber d. deut. bot Ges , \$1, 1913, 195 ) From Greek theton, sulfur and Latin orum, egg

Unicellular organisms, round to wood. Cytoplasm often concentrated at one end of the cell, the remaining space being occupied by a large vacuole. Multiplication by constriction which, in late stages, merges into fission. Actively motife; movements accompanied by rapid rotation. Flagiflation not definitely demonstrated, but type of locomotion suggests polar flagiflation. Normally containsulfur globules in the cytoplasm, hence, these are frequently concentrated at one end of the cell.

The type species is Thiorulum majus Hinze.

As in the case of Achromatium, it is difficult to establish distinct species. Those that have been described differ only in size, and the differences appear to be far from constant. For Thiosulum (Monas) milleri (Warming) Lauterborn (Verhand). Naturhist.-medizin. Vereins, Heidelberg, N. F., 15, 1915, 414) the diameter is stated by Warming (Videnskah. Meddel. naturhistor. Foren., Kjöbenhavn, 1875, No. 20-23, 363), Hinze (Ber. d. deut. bot. Ges., 51, 1913, 191) and Lauterborn (loc. cit., 415) respectively to be 5.6 to 15, 13 to 15 and 5 to 13 microns. The ovoid cells of Thiorelum majus are noted as being 11 to 18 microns long by 7.2 to 9 microns wide. In view of the regular occurrence of all intermediate sizes it seems best to recognize only a single species at oresent.

1. Thlovulum majus Hinze. (Hinze, Ber. d. deut. bot. Ges., \$1, 1013, 105; in-louding Thiorulum minus Hinze, idem.; Monas mulleri Warming, Videnskab. Meddel. naturhistor. Foren., Kjöbenhavn, 1878, No. 20-23, 303; Achromalium mulleri Migula, Syst. d. Bakt. \$, 1900, 1038, Thiowulum mulleri Lauterborn, Verhandl. Naturhist.-medizin. Vereias, Heidelberg, N.P., 13, 1915, 414.) From Lattin major, large

Unicellular organisms, spherical to ovoid Cytoplasm often concentrated at one end of the cell, the remainder being occupied by a vacuole. Multiplication by constriction which, in late stages, merges into fission. Size of cells, 5 to 20 microns in diameter.

The most characteristic feature is its motility; it is the only one of the spherical to avoid, colorless sulfur bactera capable of rapid movement. Flageliation has not been definitively demonstrated, but the type of locomotion suggests the presence of polar fixedia.

Normally contains sulfur droplets in cytoplasm, frequently concentrated at one end of cell.

Microaerophilic; apparently requires hydrogen sulfide.

Habitat: In sulfide-containing water, usually accumulating near the surface. Often in cultures of decaying algae Both in fresh water and marine environments.

### Genus III. Macromonas Utermahl and Koppe.

(Verhandl, Intern Ver f. Theoret, u. angew. Limnologie, 1923, 86.) From Latin macro, large and monas, a unit or cell

Colorless, cylindrical to bean-shaped bacteria, sctively motile by means of a single polar flagellum. Multiplication by constriction (fission). Chiefly characterized by the occurrence of calcium carbonate inclusions in the form of large spherules. In their natural habitat they may also contain small sultar globules.

The type species is Macromonas mobiles (Lauterborn) Utermobl and Koppo.
Two species have primarily been distinguished on the basis of cell size. Whether
this is sufficiently constant to serve as a specific character has not been definitely
established. From studies still limited in scope and extent on the organisms in their
natural habitat, it appears at present that the two species should be maintamed, at
least provisionally. It is possible, however, that further observations, especially
with cultures under different environmental conditions, will show the occurrence of
intermediate types and of a greater range of variation in size of pure cultures than
what has proviously been reported.

### Key to the species of genus Macromonas.

- I. Cells measuring 12 microns or more in length and 8 microns or more in width.
- II. Cells measuring less than 12 microns in length and 5 microns or less in width.

Marcomonas mobilis (Lauterborn) Utermöli and Koppe. (Achromatum) mobi e Lauterborn, Verhandl. Naturlist. Aledizin Vereins, Heidelberg, N F. 13, 1015, 413; Mirerospira cucilians Gelahorn, Cent. f Bakt, II Abt., 80, 1920, 422; Utermöli and Koppe, Verhandl Intern. Ver f. theoret u angew Lamnologie, 1923, 80 and Uternöli and Koppe, Arch. f. Hydrobiol., Suppl Bd. 8, 1923, 224.

Coloriess sulfur bacteria, always occurring singly, slightly curved, elongated ellipsoids or cylinders with broad hemispherical ends. Length varies from 12 to 30 microns, width from 8 to 14 microns, most common size 20 by 9 microns Multriplication by constriction in the middle

Cells actively mottle by means of a single polar flagellum, distinctly visible without special staining. It is 20 to 40 microns long, and, with respect to the direction of motion, always posteriorly placed. Rate of movement somewhat sluggish, about 800 microns per minute, probably on account of high specific gravity of cells.

Normally contain small sulfur droplets and, in addition, large, roughly spherical inclusions of calcium carbonate. Two to four such crystal masers almost fill a single cell Under unfavorable conditions the calcium carbonate crystals may disappear before the sulfur ciclules.

Microaerophilie; apparently require

Habitat Fresh water environment containing sulfide and calcium ions, in shallow hasins and streams in the upper layers of the mud

2. Macromonas bipunctata (Gicklhorn)

Utermöhl and Koppe. (Pseudomonas bipunetata Gicklhorn, Cent. f. Bakt., II Abt., 50, 1920, 425; Utermöhl and Koppe, Arch. f. Hydrobiol, Suppl. Bd. 5, 1925, 235)

Cells coloriess, occurring singly, cylindrical with hemispherical ends, after cell division often temporarily pearshaped Length 8 to 12 microns, width 3 to 5 microns. Multiplication by constriction in the middle.

Actively motile by means of a singlepolar flagellum, about 10 to 15 microns long, and always posteriorly phreed with respect to the direction of movement. Hagellum delicate, not visible without staining. Bate of movement sluggish, about 600 microns per minute. Probably this slow motion is on account of the high specific gravity of the cells

Normally contain calcium carbonate crystals as inclusions. These are in the form of large spherules, one or two of which nearly fill the individual cells. Sulfur globules have not been demonstrated with certainty as yet.

Microaerophilic, but it is uncertain whether hydrogen sulfide is required. Source: From stems, leaves, etc. of fresh water plants in ponds near Graz, Austria

Habitat: Fresh water environments containing calcium ions, but it has been found in sulfide-containing as well as in sulfide-free water. In shallow begins and streams in upper layers of the mud-

Note. Another species in this genus is Macromonas hyslins (Gickliborn) Utermild and Koppe. (Pstudomonas hyslina Gickliborn, Cent. f. Bakt., H. Abt., 50, 1920, 429, Utermild and Koppe, Arch [Hydrobiol, Suppl., 5, 1925, 225) Similar to Macromona bipunctata.

# APPENDIX TO ORDER CHLAMYDOBACTERIALES

A recently recognized order of filamentous bacteria includes organisms similar in many ways to those included in Chlamydobacteriales.

# ORDER CARYOPHANALES PESHKOFF.

(Jour. Gen. Biol., (Russian), 1, 1940, 611, 616.)

Filamentous or bacillary bacteria of variable size characterized either by the presence of a central body or a ring-like nucleus which frequently takes the form of a disk. These bodies are clearly visible in the living cells. The nucleus clements give a clearent Feulgen reaction. The filaments may be enclosed in a sheath. Coloriess The individuals consist of cylindrical cells enclosed in a continuous sheath or they are tube-like coenceytic organisms containing varying numbers of ring or disk-like nuclei separated from each other by alternating protoplasmic segments. These may distingate into mononucleate eoccoid cells. Gonida sometimes formed. Found in water and in the intestines of arthropods and vertebrates.

# FAMILY I. PONTOTHRICACEAE PESHKOFF.

Jour. Gen. Biol. (Russian), 1, 1940, 611, 616.)

to a first of the first section and another than

living forms.

# Genus I. Pontothrix Nadson and Krassilnikov.

(Comp rend. Acad. Sci. de U.R.S.S., A, No. 1, 1932, 243-247.) Characters as for the family.

The type species is Pontothrix longissima (Molish) Nadson and Krassilnikow.

1. Pontothrix longissima (Molish) Nadson and Krassilnikow. (Chlamydothrix longissima Molish, Cent. f. Bakt., II Abt., 33, 1912, 60; Nadson and Krassilnikow, loc cit., 243.) Cells in the fila-

ments, 1.5 to 2.0 by 1.0 to 5.0 microns. Filaments 0.5 cm in length. Cells show a central chromatin body. Found on Zostera marina in the Bay at Sebastopol on the Black Sea.

# FAMILY II. ARTHROMITACEAE PESHKOFF.

(Jour. Gen. Biol. (Russian), 1, 1940, 611, 616.)

Filaments probably divided into cells although septa (protoplasmic?) disappear during sporulation. Disk-like nuclei alternate with thin protoplasmic segments (septa). Spores form in the distal ends of filaments. Non-motile. The filaments are attached by a spherical body in groups to the intestinal wall of inserts, crustaceans and tadpoles

# Genus I. Arthromitus Levdy.

(Proc. Acad Nat Set., Philadelphia, 4, 1849, 227)

Characters as for the family. Although the description is worded somewhat differently, there does not seem to be any essential difference between this and the following genus

The type species is Arthromitus cristatus Leidy

<sup>\*</sup>Arranged by Prof. Michael A. Peshkoff, Institute of Cytology, Acad. of Sci., Moscow, U.S S R., April, 1947

- 1. Arthromitus cristatus Leidy (Proc Acad. Nat. Sci , Phila , 4, 1849, 227 and Jour. Acad. Nat. Sci : Phila , 4, 1849, 227 and Jour. Acad. Nat. Sci : Phila , 8, 1881, 433.) From the intestine of the milliped (Julus margunatus) and the termite (Retualiterms facipes). Filaments delicate, straight or inflected, growing in tutts usually of moderate density, from minute, attached, yellowish rounded or oval bodies Articuli short, cylindre, uniform, length 2.75 microns, width 0 6 micron, to trace of interior structure Length of filament 67 to 543 microns, breadth 0 6 micron.
- Arthromitus intestinalis (Valentin) Peshhofi. (Hygrocrocis intestinalis Valentin, Report f. Anat u Phys. 1, 1836, 00; Peshhoff, Jour Gen Biol. (Russian), 1, 1940, 597.) From the intestine of the
- cockroach (Blatta orientalis). Chatton and Perard (Compt rend. Soc Biol, Pans, 74, 1913, 1180) conclude that this species and Arthromitus cristatus Leidy are of the same genus although they accept the name Hygrococis as having priority However, the latter is invalid as a bacterial genus because it was given earlier as the name of a genus of algae. See Buchanan, General Systematic Bacteriology, 1925, 183.
- 3. Arthromitus nitidus Leidy. (Smithsonian Contributions to Knowledge, \$, 1852, 35.) From the intestine of the milliped (Julus marginatus).
- 4 Arthromitus batrachorum Collin. (Arch Zool. Expér et Gén , 51, 1913, 63) From the alimentary tract of toad tadpoles (Bufo calamila)

# Genus II Coleomitus Duboscq and Grassé

(Coleonema Duboscq and Grassé, Arch Zool Expér. et Gén , 68, 1929, Notes et Revue, 14, not Coleonema Bartl and Wendl , 1924, fam Rulareae, Duboscq and Grassé, Arch Zool Expér et Gén . 70, 1930, N et R , 28)

Long filaments, divided by partitions Bacillary elements in basal region. Ovoid or ellipsoidal spores in other parts of filament originating by transformation from these bacillary elements through sporoblasts

The type species is Coleomitus prurots Duboseq and Grasse

 Coleomitus pravoti (Duboseq and Grassé) Duboseq and Grassé, (Coleonema pruvoti Duboseq and Grassé, Arch Zool. Expér. et Gén., 68, 1929, Notes et Revue, 14, Arch Zool. Expér. et Gén., 70, 1930, N. et H., 23) In the intestine of a ternite (Kalaternes sp.) from the Loyalty Islands. Filaments with hyaline sheath, length variable up to 320 microns, breadth 1.3 microns Bacillary elements 3 to 4 microns long, also elements up to 6 microns with a chromate graule or dise in the middle of the lody. Spores ellipsoid 0.5 to 9 by 17 to 20 microns, all containing an executivally placed granule of viberts.

#### FAMILY III. OSCILLOSPIRACEAE PESHKOFF,

(Jour, Gen Biol (Russian), 1, 1910, 611, 616)

Bacillary and filamentous forms Filaments are most probably partitioned to form narrow cells each containing a central chromatin body (disk-like nucleus). These give a clear Feulgen reaction, and are embedded in hydine protoplasm. Spores are formed by a fusion of 2-3 protoplasts of neighboring cells. Actively motile The character of the motion sugcets the presence of peritrichous flagella. Parasitic in the intestinal tract of vertebrates. Members of the genus Sporocytophaga are not known to produce fruiting bodies as such, but often dense agglomerations of shortened rods or cocci have been noted; these may be interpreted as primitive forms of fruiting bodies.

Physiologically most species show great similarity, preferring substrates rich in cellulosic or other complex carbohydrate materials.

Most of the known species are saprophytic or coprophilic and may be found on dung, in soil, on rotten wood, straw, leaves, etc. They frequently appear to live in close association with various true bacteria and are probably parasitic on them Many have been cultivated on dung. One species is aquatic and parasitic on an alga, Cladophora sp (Geitler, Arch. f. Prostistenol., 50, 1924, 67). One is parasitic (?) on lichens and some are halophilic marine forms (Stanier, Jour. Bact., 40, 1940, 623). Another species is reported as pathogenic for fish (Ordal and Rucker, Proc. Exper Biol and Med, 55, 1944, 15).

Culture media. The myxobacteria are frequently cultured by transferring to dong. For certain species sterilized dung has been reported as less favorable than the unsterilized. Dung decoction agar has often been employed. Among the early investigators, Quehl (Cent. f. Bakt., II, Abt., 16, 1906, 9) secured slow growth of some species on malt extract-gelatin at 18° to 20°C with digestion of the gelatin. Potato-nutrient agar was reported better than dung agar, while no growth occurred on sterilized potato alone Peptone was considered necessary; glucose had little effect. Pinoy (Comp. rend. Acad. Sci. Paris, 187, 1913, 77) claimed that satisfactory development of Chonrend conceause depended upon the presence of a species of Microeccus in the medium Kofler (Sitzber d. k. Akad. Wiss., Wien, Math. Nat. Klasse, 122 Abt., 1913, 845) successfully used a sucrose-peptone agar to which was added pofassium and magnesium salts.

Recent evidence indicates that the carbon requirements of these organisms are met satisfactorily by the more complex carbohydrates, and frequently by their products of hydrolysis. Mishustin (Microbiology, Moscow, 7, 1933, 427), Imisenecki and Solntzeva (Microbiology, Moscow, 6, 1937, 3), Krzemieniewski and Krzemieniewska (Acta Soc Bot. Pol. 5, 1927, 102) and others have reported good growth of several species of mysobacteria on cellulose.

Beebe (Jour Bact., 49, 1940, 155) claimed several species to be facultative parasites on various true bacteria. Good growth was obtained on suspensions of killed bacterial cells in 1 5 per cent agar. Saiesko, Hitchner and McAllister (Jour. Bact., 44, 1941, 26) showed the destruction of living bacterial colonies by colonies of myxobacteria.

Temperature range. Most species cultivated in the laboratory show a minimum between 17° and 20°C though some species grow at 10°C. Maximum growth usually occurs at about 35°C and the maximum growth temperature is about 40°C. More normal fruting bodies are produced at lower temperatures.

The Krzemieniewskis (Acta Soc Bot. Pol., 6, 1927, 102) report that the fruiting bodies of Meditlangium boletus, Myzococcus virescens, Chondrococcus coralloides, Archangium gephyra and Archangium primgenium var. assurgens first develop, followed by Polyangium fuscum and P fuscum var. elatum At 30°C they appear in about 5 to 7 days, and at 10° to 12°C in 24 to 30 days. Each 10°C rise in at 17° to 20°C in 8 to 12 days, and at 11° to 14°C in 24 to 30 days. Each 10°C rise in the presture approximately halves the time Other species are slower in developing.

The vegetative rods. The vegetative cells are long, flexuous rods, often 30 times as long as broad
Thaxter noted rods up to 15 microns in length though these appear abnormally long
In general the cells are cylindrical, more rarely tapered or pointed at the ends
Jahn (1924, loc et ) described spindle-shaped cells. Thaxter (flot. Gaz , 37, 1904, 405) believed that a highly elastic wall was present; other authors have

fouled to prove it by plasmolytic agents. John states that tinctorial and chamical methods failed to definitely show the presence of a membrane, but that the elasticity of the cells show this clearly. The cells are flexible, not rivid as are ordinary bacteria Reche (Jour. Bact. 41, 1941, 214) reported the presence of a cell membrane in Murococcus ranthus, often made visible with proper staining procedures. The cells frequently show one or more refractive granules. Tharter also noted nucleus-like granules in the spores of Murococcus, while Bauer (Arch, f. Protistenk, 5, 1905, 92) reported that during remination of the spores of Muzococcus a refractile granule is found at each end of the cell Badian (Acta Soc Bot Pol., 7, 1930, 55) stated that the cell of Muzococcus virescens lacks a true nucleus, but that there is present a basophylic structure probably nuclear in nature. It is dumb-hell-shaped and divides longstudingly in mitosis. In space formation an autogramy occurs followed by what annears to be a reduction division. All chromatin material was Gram-negative except. during reduction; it may be stained by bematoxylin. Beebe noted a condensed mass of nuclear material in the vegetative cells of Muzococcus zonthus that dissided by constriction prior to each cell fission. Nuclear division is considered to be nonrandom amitosus Cell division is by means of constriction at a point near the center and is always complete. The nucleus is stained by centian violet and by con-homatoxylin and gives a faintly positive Feulgen reaction. What appears to be an autogamous fusion of chromosomes takes place during sporulation, followed by a nuclear division during germination of the spores The spores cerminate by a process analagoes to budding Vahle (Cent f Bakt, II Abt, 25, 1909, 178) found fat globules and occasional small volutin granules in 3 to 4 day old cultures. Glycoren was not

In masses the vegetative rods may be somewhat reddish in color. Thatter suggested the possibility that the color might be bacteriopurpurin. Treated with concentrated sulfuric acid the pigment gives a blue reaction, hence Jahn (1924, loc. cit.) concludes it to be carotin.

Motility of the cells. Bour (loc cit) states that cells have a power of forward movement at a rate of about 10 microns per minute. No flagella are present. The reells do not "awim". They may bend and are unlike most true barteria in this respect, though Dobell (Quart Jour of Microscop Science, 56, 1911, 393 and Arch f Protistendinde, 26, 1912, 117) describes such flexibility for the givin bacteria (see Bacillus ficzilis). This is characteristic also of Begginton, Oscillatoria and Surcocharla.

The cells en masse move in a "front," advancing and leaving behind a slime. The cells in general tend to lie on rather than in the slime. The exact mechanism of motion has proved puzzling. Jahn believes the motion to be related to that of forms like Oscillatoria, and to be due to excretion of alime from the cell, probably an asymmetrical exerction which pushes the cell along.

The colony. This has been variously termed a swarm, pseudoplasmodium, plasmodium and reproductive communalism. It bears a faintly superficial recemblance to the plasmodium of certain of the slame modes (Mycomycetes) but differs in that the true plasmodium is composed of the fused lodies of large numbers of amoeboid cells. The mycobacterial colony is an aggregation of individual and-absped, bacterial cells that are not amoeboid. The slame produced by the cells is not protoplasmic, and the colony is not motife but increases in size as the cells more away from the center,

. . . . . . . .

والمراجع والمحارب والمحفور الأبهاب

Thavter proposed the term "pseudoplasmodium" as a satisfactory descriptive name for the vegetative colony, while Jahn preferred the use of "swarm stage." Inasmuch as the term "colony" in relation to bacterial growth implies large numbers of vegetative cells developing as a unit without regard for size, shape or structure, it is equally suitable. Stanier (Bact. Rev., 6, 1942, 183) speaks of the condition as "reproductive communalism."

Pigmentation of the fruiting bodies is commonly employed in the differentiation of species. Species that produce coloriess cysts and some with black pigment have been reported; in general the fruiting bodies are brightly colored in shades of yellow, red, orange or brown. The color seems to originate in the slime or cyst walls rather than in the encysted cells; its nature is not well understood. The Krzemieniewskis (Bull. Acad Polon. Sci. Lettres, Classe Sci. Math. Nat., Scr. B, Sci. Nat., I, 1937, 11) noted that the orange-red fruiting bodies of Sorangium compositum became graybrown in strong alkali; the pigment was highly soluble in acetic acid and alcohol and easily soluble in other and chloroform. It was insoluble in benzol, carbon disulfide and petroleum other. They suggested that it was a carotin derivative rather than true carotin.

Beebe (1941, loc. cit.) found that the pigments of Polyangium fuscum, Podangium erectum, Myrococcus virescens, Chondrococcus blasticus and Myrococcus ranthus gave typical carotin reactions in concentrated sulfuric acid, but were insoluble in chloroform, ether, acctone and methyl and ethyl alcohol. An atypical carotin reaction resulted with hydrochloric and nitric acids. He concluded the pigments to be related to the carotins.

The fruiting bodies. After growth as a vegetative colony the pseudoplasmodium usually forms fruiting bodies which may in the different species be of many shapes and sizes. Differentiation of species, genera and families is based almost entirely upon the character of fruiting body developed. In some cases a stalk is produced, in some not.

In some forms the stalk is delicate and white, consisting of little-changed slime, in other cases it may be still and colored. The rods evidently are carried up by the slime which they secrete. In some forms the stalk is simple and short, in others relatively long and branched.

The rods ordinarily associate in more or less definite clumps to form cysts. These evets may be sessile or stalked. Usually the rods shorten and thicken materially before the cyst ripens. In some forms they shorten so much as to become short evoid or cylindrical, functioning as spores. They are not endospores such as are found in the genus Bacillus.

The cysts may or may not possess a definite membrane produced from slime. Usually the cysts are bright colored, frequently red, orange or yellow. The spores within the cysts when dried retain their vitality for considerable periods of time. Jahn records germination of Polyangum fuscum after 54 years, of Myzococcus fulvus after

8 years.

Methods of isolation. One technic of isolation used by the Krzemienierskis (1927, loc. cil ) was to sieve the fresh soil, place it on blotting paper in petri dishes, and add sterilized rabbit dung. The soil was saturated with water to 70 to 100 per cent, and the plates incubated at 26° to 30°C. After 5 to 10 days fruiting bodies began to appear on the dung. Numerous species were isolated by this method.

Mishustin (loc cil ) employed silica gel plates on the surface of which sterilized filter paper had been placed. Small lumps of soil were placed on the filter paper and the plates incubated for several days at various temperatures. Vegetative myxobacterial colonies developed around the inocula and were purified by transfer to fresh cellulose plates

Beche reported a modified Krzemieniewski technic to be satisfactory. Fruiting bodies that had developed on sterilized rabbit dung were transferred to bacterial suspension agar plates. Associated bacteria failed to grow well, but myvobacteria developed rapidly.

The species of the genera Cytophaga and Sporceytophaga require special technics (Stamer, Bast Rev., 8, 1942, 143) The soil forms which decompose cellulose may be enriched with a medium consisting of cellulose (usually in the form of filter paper) and a neutral or slightly alkaline mineral base containing either ammonium or nitrate sails as introgen source. For certain species chitin may be substituted for cellulose Pure cultures may be secured by use of soft agar (I per cent or less) with finely divided cellulose or with cellulose detritins (Fuller and Korman, Jour. Bact., 46, 1943, 281).

Cultivation of organisms. Pure cultures of many species have been grown upon varous media and substrates Sterilized dung, dung decoction agar, nutrent agar, potato and potato agar, sterilized lichens, etc. lave all been used Little study has been made of the food requirements. Recent evidence indicates the utilization of some of the more complex carbohydrates. Insecench and Solntzeva Gifferobology, Moscow, 6, 1937, 3) reported the growth of certain species on cellulose with partial decomposition of that compound Mishustin (Microbiology, Moscow, 7, 1933, 427) solated five species of cellulose-decomposing myrobacteria, cultivating them on a mineral sall-selica gel medium to which filter puper had been added as a source of carbon. Krzemieniewska (Acta So: Bot Folon, 7, 1930, 507) grew species of the Cyuphagozace on celluphane, while Stapp and Bortels (Cent. f. Bakt, II Mht., 90, 1931, 28) record the growth of other members of the same family on media containing

extract to be the only suitable nitrogen sources for the Cytophagaceae, inorganic salts and amino acids failing in this respect. Agri and cellulose were decomposed, while clitin and starch were not utilized. Johnson (Jour. Bact., 24, 1032, 333) and Benton (Jour. Bact., 29, 1053, 419) both reported clitinovorous myvolucteria. Beebe (Jona State Coll. Jour. Sci., 15, 1911, 319 and 17, 1913, 227) claimed growth of species of Polyangium, Podangium, Chondrocecus and Myzococcus on 1.5 per cent agar with no other nutrients added. Peptone appeared to aid development, while the addition of the efective thad no favorable effect. Moderate growth occurred on a mineral saltagar medium without the addition of carbon or nitrogen sources. Growth was stimulated by the addition of strous complex carbohydrates including cellulose and starch, the latter being by droly red, complete inhibition resulted with pentoses and hexores Beit growth was reported on a medium composed of dried beternal cells suspended in 1.5 per cent again. The suspended cells were lysed by the my solucteria.

The Kremieniewskie (Acta See Bot Pol., 5, 1927, 102) showed that the optimum hadrogen son concentrations for growth of different species were found between pH 36 and 80. Becke (1941, be cit) reported no growth of any species below pH 60, while moderate development was noted up to pH 90.

Habitat and distribution. Many species have been described from dung. The work of the Kirzenneewskis (Arta See Bot Pol. 5, 1927, 192), Mishastin (Merg-bodey, Moscow, 7, 1938, 427), Imfencels and Solutiesy, (foc. ct.) and others seem to indicate that they occur commonly in soils, particularly soils under cultivation or high in organic materials. Different species appear to be characteristic of various

types of soils. Polyangium cellulosum var. ferrugineum Mishustin and Polyangium cellulosum var. fuscum Mishustin (loc. cil.) were observed to be common in the black soils of Eastern European Russia, while a similar variety of the same species nas reported only from podcol soils. Species of the families Polyangiaceae, Sorangiacea and to a lesser degree Archangiaceae appear to predominate in Russian and European soils, while the soils of Central and Western United States seem to be more suitable for the growth of the Myzococcaccae. Soils of mountainous regions are said to contain fewer numbers of myxobacteria than those of lowland areas.

The distribution of myxobacteria in the soil seems to show a relationship to the hydrogen ion concentration. Some species are found only in neutral or alkaline soils (pH 7.0 to 8.0), others only in acid soils (pH 3.6 to 6.4). Some species show a wide tolerance (pH 3.6 to 8.0).

Relationships of the Myxobacteria. The resemblance of the pseudoplasmodium of the myxobacteria to the plasmodium of the slime molds is as noted above probably to be regarded as without significance, as is also the superficial resemblances of the fruiting bodies of the two groups. Jahn (1924, loc. cit.) dismisses the relationship to the Thiobacteriales suggested by Thatter as improbable. Thaxter believed the pos session of the red color might show presence of bacteriopurpurin; but Jahn found a carotin reaction which argues against this idea. Jahn insists upon a close relationship to the blue-green algae, particularly because of the mobility of the cells and the creeping motion. He does not believe all Schizophylae that do not belong to the Cuanophyceae (blue-green algae) should be grouped as bacteria. He believes the myxobacteria to be more closely related to the blue-green algae than to the true bacteria, and creates the class Polyangidae to be coordinate with the class Schizomyectes In this he ignores the equal evidence of close relationship of the sulfur bacteria to the Cyanophyceae. His argument would lead to the recognition of all the orders of bacteria recognized in this Manual as classes. The wisdom of this is not apparent. The Myzobacteriales may be regarded as a well-differentiated order of the Schizomyccles showing some resemblance to the true bacteria on the one hand and the Myzophycege (Cyanophyceae) and Thiobacteriales on the other.

Families of the Myxobacteriales. The division of the order Myxobacteriales inlo families has been based, in all classifications proposed, upon morphology. The faal demonstration by Stanier (Jour. Bact., 40, 1940, 636) of the close relationship between species of the genus Cytophaga and the myxobacteria led him to propose the recognition

of a new family, Cytophagaceae

The principal character differentiating this family from the four previously reconized is the absence of differentiated fruiting bodies. The resting cells are red-shaped
in the genus (Cytophaga). In another genus recognized by Stanier (Sprocytophaga)
the resting cells are spherical. This brings the taxonomist face to face with the
problem of deciding whether the presence of fruiting bodies or the spherical shape
of the spores should be the primary basis of differentiation. The formation of
substructed shores is believed to be of sufficient significance to require the inclusion of
Sprocytophaga, although

s family, while those forms

which produce neither spherical spotes not running, dies (genus Cylophaga) are

the and family Culaphagaceae. 1933,

rods with ends almost truncate, and roug, standard (Bact. Rev.,  $\theta$ , 1912, 143) as also the cases with pointed tips) is supported by Stanier (Bact. Rev.,  $\theta$ , 1912, 143) as also

conclusion that the family Archangiaceae should be abandoned (Krzemieniewski and Krzemieniewska, Bull. Acad. Pol. Sci. Lettres, Classe Sci. Math. Nat., Scr. B., Sci. Nat., 1, 1937, 11-31) and the genera and species redistributed. The validity of the argument is accepted, but the family is retained until a satisfactory revision can be effected. This should be based on a careful comprastive study of the species

## Key to the Families of Order Myxobacteriales.

- Neither definite fruiting bodies (eysts) nor spores (microcysts) produced.
   Family I Cytophagaccae, p 1012
   Spores (resting cells, microcysts) produced.
  - A. Resting cells (spores, microcysts) produced.

    A. Resting cells (spores, microcysts) elongate, not spherical or ellipsoidal Fruit
    - ing bodies (cysts) produced

      1 Fruting bodies (cysts) not of definite shape; cells bean up to produce
      - 1 Fruiting bodies (cysts) not of definite shape; cells heap up to produc mesenteric masses or finger-like (columnar) bodies. Family II. Archangiaccae, p 1017.
      - 2 Truiting bodies (cysts) of definite shape
        - a. Cysts usually angular. Vegetative cells usually thick and short, with blunt, rounded ends.
        - Family III Sorangiaceae, p 1021 aa Cysts usually rounded. Vegetative cells long and thin, sometimes
      - spindle-shaped with pointed ends
        Family IV Polyangiaceae, p. 1023
    - R Resting cells (spores, microcysts) spherical or ellipsoidal Fruiting bodies produced except in genus Sporocytophaga

Family V. Myzococcaceae, p 1010.

## FAMILY I. CYTOPHAGACEAE STANIER.

(Jour. Bact., 49, 1949, 630.)

Flexible, sometimes pointed rods, showing creeping motility. No fruiting bodies or spores (microcysts) formed. There is a single genus Cytophaga.

> Genus I. Cytophaga Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 578.)

Diagnosis: As for family. From Greek kytos, hollow place or cell; and phagein, to eat, devour.

The type species is Cylophaga hutchinsonii Winogradsky.

Key to the species of genus Cytophaga.

I From soil.

A. Do not utilize starch.

- 1. Produce yellow pigment on cellulose.
  - Cytophaga hutchinsonii.
  - 2. Cytophaga lutea.
- 2. Produces orange pigment on cellulosc.
  - 3. Cytophaga aurantíaca.
- 3. Produces pink pigment on cellulose.
  - 4. Cytophaga rubra.
- 4. Produces olive-green pigment on cellulose. 5. Cytophaga tenuissima.
- B. Utilize starch.
- 1. Produces yellow to orange pigment on starch. 6. Cytophaga deprimata.
- 2. Produces cream to pale yellow pigment on starch. 7. Cutophana albonilea.
- II From sea water.
  - A. Dark pigment on cellulose
    - 8. Cytophaga krzemieniews ae.
  - B. No pigment on cellulose.
- 9. Cytophaga diffuens.
- C Liquefies agar.
- 10. Cytophaga sensitiva.

1. Cytophaga hutchinsonii Winogradsky. (Winogradsky, Ann Inst. Pasteur, 43, 1929, 578; Cytophaga strain 8, Jensen, Proc. Linn. Soc. N. S. Wales, 65, 1940, 547; not Cylophaga hutchinsoni Imšenecki and Solntzeva, Bull. Acad. Sci U.S.S.R., Ser. Biol., No. 6, 1936, 1129.) Etymology: Named for H. B. Hutchin-

son.

Rods: Highly flexible, occurring singly, 0.3 to 0 4 microns wide at the center and tapering to both ends Length 3.0 to 6.0 microns, according to Krzemienienska (Arch. Mikrobiol., 4, 1933, 396); 1.8 to 4.0 microns, according to Jensen (loc. cil.) May be straight, bent, U-shaped or Sshaped Stain poorly with ordinary aniline dyes. With Giemsa's or Winogradsky's stain young cells are colored uniformly except for the tips, which remain almost colorless; in older cells there is a concentration of chromatin material at the center. Old cultures show large coccoid cells which are not readily seen. Gram-negative.

Growth on cellulose, cellulose dectrins and glucose. On mineral salts-silica gel plates covered with filter paper, bright yellow glistening muchaginous patches are produced after a few days. The filter paper in these regions is gradually completely dissolved and the patches become translucent.

Ammonia, nitrate, asparagin, aspartic acid and peptone can serve as sources of nitragen according to Jensen floc set 1

Strictly aerobic.

Optimum temperature 28° to 30°C. Source: Isolated from soil.

Habitat Soil. Decomposes plant residues

### Cytophaga lutea Winogradsky. (Ann. Inst. Pasteur, 43, 1939, 599)

Etymology: Latin Iuleus, yellow.
Dimensions of the cells approximately those of Cytophaga aurantaca (see below) but rather larger and thinner and without marked central swelling. Gramporative.

Produces a brilliant yellow pigment similar to that of Cylophaga hulchingonis. This species differs only in size from Culophaga hulchingoni, and is probably a

variety of it.

orange-colored.

Source Isolated from soil.

Habitat Soil. Decomposes plant re-

3 Cytophaga aurantiaca Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 597; probably Mycococus cytophagus Unlas Arch Merchiol 1, 1929, 31,

Bokor, Arch. Microbiol , 1, 1930, 31 )
Etymology Modern Latin aurantiacus.

Cells 1 0 micron wide at the center by 6 to 8 microns long | Except for size, very similar to thore of Cytophaga hutchingonia Gram necestive

Produces orange mucilaginous patches on filter paper-silica gel plates. Fibrolysis is very rapid and intense

Source - Isolated from soil.

Habitat: Soil. Decomposes plant residues.

 Cytophaga rubra Winogradsky. (Ann. Inst. Pasteur. 45, 1929, 508.)

Ltymology: Latin ruber, red.

Pointed rods, straight or sometimes slightly bent, occasionally hooked at one end. Length approximately 3 microns. Gram-negative.

Produces diffuse, rapidly-spreading, pink to brick-red patches on filter papersilica gel plates. Fibrolysis is much slower and less extensive than that caused by Cutonhaga hutchinsonii.

Source: Isolated from soil.

Habitat: Soil Decomposes plant residues.

5 Cytophaga tenuissima Winogradsky. (Ann. Inst. Pasteur, 43, 1929, 509; incorrectly spelled Cytophaga ternissima in Berrey et al. Manual 4th et 1921, 559.)

Etymology: Latin tenuissimus, most tenuous, very slender.

Dimensions of cells not given, but described as being extremely slender. Gram-negative.

Produces mucilaginous, greenish to olive patches on filter paper-silica gel plates

Source. Isolated from soil.

or sink down.

Habitat: Soil. Decomposes plant residues.

6 Cytophaga deprimata Fuller and Norman (Jour. Buct., 45, 1943, 566.) Etymology: Latin deprime, to depress

Rods. Long and flexuous with pointed ends, 0.3 to 0.5 by 5.5 to 10 microns, arranged singly Creeping motility on solid surfaces. Gram-negative.

Growth on starch agar is at first smoly to funt yellow becoming bright yellow later. Colonies are irregular and concave in elevation. The edge spreads indistinguishfully into the surrounding medium and shallow depressions develop around the rolony. Small colonies give the plate a characteristic pitted appression.

Grinth on reliulose dextrin agar is

milky white. Colonies are depressed in medium.

Gelatin is liquefied in 4 days.

Glucose, lactose, maltose, sucrose, pectin, starch, cellulose dextrin and hemicellulose are utilized. Very scant growth on cellulose may be found on first isolation.

Yeast extract, ammonium nitrate and pentone are suitable nitrogen sources.

Indole not formed.

Nitrites not produced from nitrates. No visible change in litmus milk.

Highly aerobic.

matter.

Optimum temperature 25° to 30°C.

Source: Isolated from soil. Habitat: Soil. Decomposes organic

7. Cytophaga albogilva Fuller and Norman (Jour. Bact., 45, 1943, 566.) Etymology: Latin albus, white, and

gilvus, pale yellow.

Long flexuous rods with pointed ends, 0.3 to 0.5 by 4 5 to 7.5 microns, arranged singly. Creeping motility on solid surfaces. Gram-negative.

Growth on starch agar is cream to pale yellow. Colonies are small, concave, and irregulary round. Edge is entire and irregular

Growth on cellulose dextrin agar is restricted. Colonies are pin-point. milky white in color, round and concave.

Gelatin is liquefied in 7 days. Glucose, galactose, lactose, maltose, sucrose, gum arabic, pectin, starch, collulose dextrin and hemicellulose are utilized. Very scant growth on cellulose

may be found on first isolation. Ammonia, nitrate and peptone are

suitable nitrogen sources. Indole not formed.

Nitrites not produced from nitrates. No visible change in litmus milk

Highly aerobic.

Optimum temperature 22° to 30°C Source: Isolated from soil.

Habitat: Soil. Decomposes organic matter.

Cytophaga

krzemieniewskae Stanier. (Incorrectly spelled Cytophaga krzemieniewskii in Stanier, Jour. Bact . 40, 1940, 623; Jour. Bact., 42, 1941, 532.)

Etymology: Named for H. Krzemieniewska.

Long, flexible rods, usually of even width with blunt ends, occasionally somewhat pointed and spindle-shaped. 0.5 to 1.5 by 5 to 20 microns. Starshaped aggregates occur in liquid media. Creeping motility on solid surfaces, non-motile in liquids.

Growth on a sea water-peptone agar plate begins as a smooth, thin, pale pink, rapidly spreading swarm. After a few days, the older portions of the swarm assume a warty appearance due to the accumulation of cells in drop-like masses, resembling immature fruiting bodies but always containing normal vegetative cells. A diffusible brown to black pigment which masks the pink color of the swarm is produced after about a week. Agar is rapidly decomposed, and ultimately liquefaction becomes almost complete.

Sea water-gelatin stab: Liquefaction Growth in liquid media is turbid and silky with a pink sediment; the medium turns dark brown or black after 1 or 2 weeks.

Xylose, glucose, galactose, lactose, maltose, cellobiose, cellulose, alginic acid, agar and starch are utilized, but not arabinose, sucrose and chitin.

Yeast extract and peptone are the only suitable nitrogen sources known.

Weakly catalase positive.

Indole not formed.

Nitrites produced from nitrates. Hydrogen sulfide not produced.

Salt concentration range: 1.5 to 50 ner cent.

Strictly aerobic.

Optimum temperature 22° to 25°C. Source: Isolated from sea water. Habitat: Sea water. Probably on decaying marine vegetation.

9. Cytophaga diffluens Stanier. (Jour. Bact., 40, 1910, 623; Jour. Bact., 42, 1941, 546.)

Etymology, Latin diffluens, spreading,

flowing away.

Pointed, sometimes spindle-shaped, flexible rods, 0 5 to 1 5 by 4 to 10 microns. In old cultures involution forms consisting of long, twisted, thin threads are found Star-shaped aggregates of cells occur in bound media. Creeping motility on solid surfaces, non-motile in liquids. Growth on a sea water-peptone agar

plate begins as a thin, pink, rapidly spreading swarm which often covers the entire surface in a few days. The swarm gradually increases in thickness and develops an irregular, beaten-copper surface due to the liquefaction of the underlying agar. After 4 to 5 days the color becomes orange. Liquefaction of the agar is ultimately almost complete. Sea water-gelatin stab. Rapid lique-

faction Growth in liquid media is turbid, often with suspended floccules and a heavy

pellicle

Nylose, glucose, galactose, lactose, maltose, cellobiose, cellulose, agar and Algunic acid are utilized, but not arabinose. sucrose, chitin or starch.

Yeast extract and peptone are the only autable nitrogen sources known.

Weakly catalase positive

Indole not formed

Natrates produced from natrates. Hydrogen sulfide not produced

Salt concentration range 1.5 to 50 per cent

Slightly aerobic

Ontimum temperature 22° to 25°C Source Isolated from sea water Habitat: Sea water. Probably on decaying marine vegetation.

to Cytophaga sensitiva Humm (Duke Univ Marine Lab , North Caroling, Bull 3, 1916, 61 ) Etyomology Latin sensus, to perceive

Cells long, slender, flexuus rods

Apparently not fisgellated, 08 to 10 by 7.0 to 20 microns Cell ends not tapered or only slightly so. Gramnegative. Cells exhibit creeping motility on agar with ability to reverse direction of movement without turning. Bending movements occur in houid media

Colonies light orange, thin and shin-Irregular margin. Outer part composed of a single layer of cells. spreading rapidly, the center somewhat thicker and more or less opaque, sunken in the agar. Agar liquefied. Single colony may nearly cover the surface of the agar in the Petri dish within one week, center of colony sinks to the bottom of the dish and may develop vertical sides. Usually the colony begins to die after a week or ten days from the center outward, as shown by loss of pigment. Apparently no water-soluble pigment is produced Colony 18 mm in diameter and gelase field 25 mm in diameter after three days on agar containing 0 S per cent potassium nitrate and 0 8 per cent peptone (lodine stain) Gelatin No growth.

Milk. No growht

Nitrate apparently not produced from nitrate (agar medium)

Optimum nitrate concentration of medium appeared to be 0.5 per cent. Fair growth on sea water plus agar only. and on ager containing 10 per cent potassium nitrate Slight growth on 20 per cent nitrate agar.

Optimum peptone concentration anpeared to be about 0 1 per cent; growth inhibited by concentrations of pentone exceeding 0.4 per cent No growth on agar media containing

any one of the following substances in a concentration of 0.2 per cent elucose. starch ammonium sulfate. The basal medium, however, supported excellent growth.

Repeated efforts were made to obtain a pure culture by stresking plates and by pouring plates. These were finally suc

cessful by the use of an agar medium that contained 01 per cent peptone, 005 per cent beef extract, 0.05 per cent glucose, and traces of yeast extract and ferric phosphate. Good growth on broth of this composition was also obtained. Apparently the yeast extract supplied necessary growth substances.

Source: Isolated September 19, 1915 from a mixed culture with Pseudomonas corallina, by streaking a piece of Dictyota duchotoma on agar containing 0.2 per cent potassium nitrate.

Habitat: From scaweed. Beaufort, North Carolina.

Appendix: Stapp and Bortels (Cent. f. Bakt., II Abt., 90, 1934, 28) described four new obligate cellulose-decomposing species: Cytophaga silvestris, Cytophaga anularis, Cytophaga flaricula and Cylophaga crocea. The differences between them are small and, while it is impossible to make positive identifications on the basis of present knowledge, they seem to be very similar to Cytophaga kutchinsonii. In the absence of comparative pure culture studies on the obligate cellulose-decomposing members of the genus, the proper delimination of species is not possible. Their inclusion in keys must await additional information

#### PAMILY II ARCHANGIACEAE JAHN

(Beiträge zur botan, Protistologie, I. Die Polyangiden, Geb. Borntraeger, Leinzig 1924 )

In the organisms belonging to this family the swarm (pseudoplasmodium) produces irregular swollen or twisted fruiting bodies, or develops columnar or finger-like growths, usually without a definitely differentiated membrane.

## Key to the genera of family Archangiaceae.

I Fruiting body depressed, usually irregularly delimited, the interior usually consisting of swollen or intestine-like twisted or inter-twined masses, whose windings may be constricted or may jut out (project) as free ends.

Genus I Archangium, p. 1017.

II Fruiting body consists of single (separate) columnar or finger-like structures arising from the substrate

Genus II. Stelangium, p. 1020.

#### Genus I. Archanglum John.

(Jahn, Beiträge zur botan Protistologie, I. Die Polyangiden Geb Borntraegers Leibzig, 1921, 67, Ophiocustia Enderlein, Bermerkungen zur Systematik der Chondromyciden, Berlin, 1921, 6 pp )

Etymology: Greek arche, primitive, and angion, vessel (according to Jahn, this

cenus is the most primitive).

The mass of shortened rods embedded in slime forms a pad-shaped or more munded superficially swollen or tuberous fruiting body, even with horny divisions. The fruiting body has no membrane. In the interior can be seen a mass resembling could intestines The windings of this coil may be uniform, or irregularly jointed, free or stuck together; the ends may be extended and horny. Instead of a membrane there may be loosely enveloping slime.

The type species is Archangium gephyra Jahn

## Key to the species of genus Archanglum,

I. No slimy capsules.

A. Fruiting body usually wound, irregularly constricted, sometimes swollen and vesicular, appressed

1. Fruiting body red.

a. The shortened rods 2.5 to 3 nucrons

1 Archangium gephyra as. The shortened rods 4 to 6 microns

2 Fruiting body vellow.

2 Archangium primigenium

3 Archangium flavum.

B Tube usually uniformly thick, loosely wound, often branched. 4. Archangium serpens

II Fruiting body consisting of a reddish coiled tube, embedded in yellow slime. 5. Archangium tharters.

botanischen Protistologie. I Die Poly. 1. Archanglum gephyra Jahn. (Chondrommes serpens Quehl, Cent f. Bakt., angiden, Geb Borntraeger, Leipzig. II Abt . 16, 1996, 16, Jahn, Bestrige zur 1721, 67.)

Etymology: Greek gephyra, a bridge. So named because a transition form between the Archangiaceae and the Myzococcaceae.

Swarm stage (pseudoplasmodium); Grows easily in manure decection, forming a pseudoplasmodium and ring of fruiting bodies. The vegetative rods are about 10 microns long, 0.5 micron in diameter.

Fruiting bodies: Up to 1 mm in diameter, of irregular form and with swollen or padded surface. Average sized fruiting bodies are a reddish flesh color by reflected light; smaller fruiting bodies, a light rose. On a dark background large fruiting bodies when fresh appear bluish violet. By transmitted light the fruiting bodies appear yellowish to light red. Upon addition of alcohol or when heated in glycetine, they lose the color quickly and uppear gray or colorless.

The inner structures are for the most part a mesenteric mass of tubes 40 to 60 microns wide, without any membrane, and without any enclosing slime. The convolutions are often pressed together. On the inside of these tubes there appears definitely a septation by straight or slightly arched cross walls which, however, do not always out entirely through the spore masses from one side of the tube to the other. Upon pressure, the fruiting body breaks up into a number of small fragments about 15 to 30 microns in diameter. Within these fragments the shortcened rods lie parallel and in bundles.

The rods in the fruiting bodies are so shortened that they resemble the spores of the Myxococaccae. The spores are 2.5 to 2.8 microns long and about 1.4 microns wide. Often they are somewhat bent so that they appear to be bean-shaped. In the smooth, transparent tips of fruiting bodies they stand closely parallel to each other, so that in transmitted light one sees only their cross section and is at first led to believe that

he is dealing with one of the Myzo. coccaceae.

Source and habitat: Found frequently in the region of Berlin on the dung of deer, rabbits, and hare, once also on old decaying lichens. Easily overlooked on necount of its usual bluish color. According to Krzemieniewski (1927) the most common of myxobacteria in the soils of Poland. Isolated on rabbit dune.

Illustrations: Quehl (loc. cit.) Pi. 1, Fig. 7. Jahn (1924, loc. cit.) Pl. 1, Fig. 5 Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. III, Figs. 25-26.

 Archangium primigenium (Quehl) Jahn. (Polyangium primigenium Quehl) Cent. f. Bakt., JI Abt., 18, 1906, 16, Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924.)

Etymology: Latin, primigenius, primitive, referring to the simple and primitive character of the fruiting body.

Swarm stage (pseudoplasmodium): In manure decoction cysts germinate readily. Vegetative rods 4 to 8 microns in length

Fruiting bodies: Up to 1 mm in diameter, sometimes larger, with irreqularly padded swollen surface; when fresh a lively red color which is quite prominent especially against a dark background; when dried, dark red. In transmitted light flesh red to yellowish red. In alcohol and upon heating it is quickly bleached.

In transmitted light one sees that the fruiting body is made up of numerous intestine-like convolutions closely appressed, not honever, always definitely delimited. These tubes usually have a diameter of from 70 to 90 microns, often constricted and attenuated. No membrane is present. The rods in the fruiting bodies are about 4 microns long and 0.5 micron wide. Upon pressure on the truiting bodies, the rods remain together in small fragments of various sizes.

2a. Archangium primigenium var.

assurgens Jahn. (Jahn, Beiträge zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 5, 1924, 69; Archangium assurgens Krzemieniewski, Acta Soc. Bot 'Poloniae, 1927, 95.)

Etymology: Latin assurgera, rising up Size and color of the fruiting body as in the species, likewise the inner structure, size and arrangement of the rods. However, the tubules which together constitute the fruiting bodies are more or less free at their ends and stand up from the substrate. Their diameter is somewhat less (about 15 microns), they are often convoluted so that they many times appear to be constricted (like pearls).

Pronounced races of the species and of the variety are so different in habits that they may be regarded as distinct species. Jahn believes the presence of intermediate strains makes a separation

difficult

Source and habitat: According to Jalin, Archangum prinigenum is not particularly common. It is usually found on rabbit dung, sometimes on roc dung. The wariety assurgens is relatively rare (found three times on rabbit dung). Koffer (1930) on rabbit dung, Vienna. Very tare in Polish soils according to Kircemeniewski (1927).

Illustrations Quobl, Cent. I Bakt, II Abt. Id., 1906, Id. Pt. I, Fig. 5, Jahn, Kryptogamenfors d Mark Brandenburg, V, Pdre I, Left 2, 1911, 291, Pt. I, Fig. 5, Jahn (1921, Ioc. et l.) Pt. 1, Fig. 4, also Fig. G, page 37, Kreeninenevski 1920, Ioc. et l.) Pt. II, Fig. 23, 1927, Ioc. et l.) Pt. IV, Fig. 3 vir. dissurgens, Pt. IV, Fig. 1 and 2.

3 Archangium flavum (Kofler) Jahn (Polynnjum farum Kofler, Stither d Kais Akad Wiss Wen Math. Nat Klasse, 122 Ab., 1913, 861, Jahn, flettrige gur Intamichen Prinistologie I Die Polyangulen, Geb Borntrager, Leipig, 1921, 71) Etymology: Latin flavus, golden or reddish-vellow.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: About 0.5 mm in diameter, yellow, spherical or oval, with humped or pudded surface. The mass of cells quite homogeneous, upon pressure under cover glass single sections tend to adhere No membrane, though the rods are so tightly linked that when cautiously placed under a cover glass, the form of the fruiting body is retained. Rods 2 to 4 micross.

Source and habitat, Kofler (1924) on hare dung found in Danube meadows, Reported as frequent in Polish soils by Krzemieniewski (1926, 1927).

Illustrations: Krzemieniewski, Acta Soc Bot Poloniae, 4, 1926, Pl. II, Fig 24 (1927), Pl. IV, Fig. 4, 5 and 6.

4 Archangium serpens (Thavter) Jahn. (Chondromyces serpens Thavter, Bot. Gaz, 17, 1802, 403; Jahn, Beiträge zur botanischen Protistologie I. Die Polyanguden, Geb Borntraeger, Leipzig, 1921, 72)

Etymology Latin serpens, erecping Swarm stage (pseudoplasmodium); Rods cylindrical, 0.6 by 5 to 7 microns. Cultures on agar develop convoluted form.

Fruiting body. About 1 mm in diameter, recumbent, consisting of numerous loosely intertwined cysts, confluent in an anastomoting coil, flesh-colored, when dry dark red, 50 microns in diameter, bent, occasionally somewhat broadened or constricted, branched.

Source and habitat Thaxter, Bot. Gaz, 17, 18/2, 389 On decaying lichens, Cambridge, Mass

Illustrations Thanter (loc cit ), I'l. 21, Fig 21.

5 Archangium thanteri Jahn. (Beitrige zur botanischen Protistologie I Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 71.)

Etymology: Named for Dr. Roland Thaxter.

Swarm stage (pseudoplasmodium): Vegetative stages not observed. Either no germination or prompt cessation of growth on dung extract. May be transferred on dune

Fruiting body: Usually 0.25 to 0.5 mm, occasionally 0.75 mm in diameter. Irregularly rounded, auperficially sulfur yellow. Upon pressure numerous reddish convoluted tubules are observed embedded in a yellow slime. The average diameter of the tubules is about 50 microns. No membrane surrounds the tubes. They contain the shortened rods.

The fruiting body is bleached by alcohol or heat, becoming yellowish. Inveloping slime is variable. In well developed specimens the slime forms a stalk, giving the whole the appearance of a morel. In small specimens the rods are embedded in the slime. The fruiting bodies stand loosely separated on surface of dung, never in large groups. Shortened rods (spores) 0.5 micron by 3 microns, very slender.

Source and habitat: According to Jahn rare, on rabbit dung. Races with well developed stalks even less common.

Illustrations: Jahn (loc. cit.), Pl. 1, Fig. 1 and 2. Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. II, Fig. 27.

### Genus II. Stelanglum Jahn.

(Kryptogamenflora der Mark Brandenburg, V, Pilze I, Lief. 2, 1911, 205.)
Etymology: Greek stele, pillar or column and angion, vessel.

Diagnosis: Fruiting bodies are columnar or finger-like, sometimes forked, without definite stalk, standing upright on the substrate.

The type species is Stelangium muscorum (Tharter) Jahn.

 Stelangium muscorum (Thaxter) Jahn. (Chondromyces muscorum Thaxter, Bot. Gaz., 37, 1901, 411; Jahn, Kryptogamenslora der Mark Brandenbure. V. Pilze I. Lief. 2, 1911, 295)

Etymology: Latin muscus, moss. Swarm stage (pseudoplasmodium): Not

described, Fruiting body Bright yellow-orange,

90 to 300 microns long, 10 to 50 microns wide, without differentiated stalk, simple or rarely fureate, upright, elongate, compact or slender, narrowed at tip Roda (spores) 1 to 1.3 by 4 to 6 microns.

Source and habitat: According to Thaxter (loc, cit.) on liverworts on living

beech trunks in Indiana.

Illustrations: Tharter (loc. cit.) Fl. 27, Figs. 16-18.

### FAMILY III SORANGIACEAR IAUN

(Beitrage zur botan Protistologie I. Die Polyangsden. Geb. Borntracger, Leipzig, 1924, 73.)

Diagnosis: The shortened rods of the fruiting body lie in angular, usually relatively small cysts of definite polygonal shape. Often many of these cysts are surrounded by a common membrane. The primary cyst may be differentiated from the angular or secondary, cyst. No stabled form are known.

#### Genus I Sprenglum John

(Jahn, Beiträge z. botan. Protistologie. I. Die Polyangiden. Geb. Borntraeger, Leipzig, 1921, 73; Cystoccomia Enderlein, Bemerkungen z. Systematik d. Chondromyciden. Berlin. 1921. 73.)

Etymology · Greek soros, heap and angion, vessel

Diagnosis. As for the family The cysts are united into rounded fruiting bodies. Eight species have been allocated to this genus.

The type energies is Sorangum schroeters Jahn.

### Key to the species of Genus Sorangium.

- I. Fruiting bodies not black when ripe.
  - A Primary cysts absent; fruiting body shows only angular, spherical or oval small cysts
    - 1 Cysts angular
      - a Fruiting body very small (50 to 80 microns), often irregularly cerebriform; the angular cysts often completely separated from each other, and about 13 nucrous in dismeter.
        - 1 Sorangium schroeteri
      - an Pruiting body composed of many small cysts.
        - b Cysts orange-red in color; over 50 microns in diameter.
        - bb Rusty brown color; cysts less than 3.5 microus in diameter.
          - 3 Sorangum cellulosum.
    - 2 Cysts spherical or oval.
      - 4. Sorangium spumosum,
  - B Both primary and secondary cysts present.

    1 Primary cysts small and numerous, about 20 microns, with definite mem
    - brane and few angular secondary cysts.

      5 Sorangium septatum.
  - 2 Prunary cysts large, with delicate, often indefinite, membrane.
- II Fruiting bodies black or brownish black when ripe.
  - - B. Primary eysts generally formed.
- 8. Sorangium nigrescens.
- 1 Sorangium schroeteri Jahn (Jahn, I. Die Polyangiden, Geb. Borntraeger, Beiträge zur botanischen Protistologie. Leipzig, 1921, 73; regarded as a synonym

of Sorangium compositum by Krzemieniewski, Acta Soc. Bot. Poloniae, 6, 1927, 96.)

Etymology: Named for Julius Schroeter (1837-1894).

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: Very small, circular, swollen, often kidney-shaped with brainlike convolutions, usually 60 microns (occasionally 120 microns) in diameter. bright orange-red. Surrounded by a delicate slime membrane about 0.7 micron thick, apparent only with high magnifications. Divided secondarily into angular cysts, by sutures extending inward which divide the mass regularly into well delimited portions, many angled, usually about 12 microns in diameter, and in other places into areas less well delimited and about 14 microns in diameter. Resembles gelatin which has dried in a sheet and cracked into regular areas. Rods in cysts 5 microns long. Cysts sometimes occur together in large numbers, covering an area to 0.5 mm.

Source and habitat Found by Jahn (loc cit.) five times on rabbit dung in environs of Berlin.

Illustrations: Jahn (1924, loc. cit), Pl. 2, Fig 22.

 Sorangium sorediatum (Thaxter) Jahn (Polyangium sorediatum Thaxter, Bot. Gaz, 57, 1904, 414, Jahn, Beiträge zur botanischen Protistologie I. Die Polyangiden, Geb Borntraeger, Leipzig, 1024, 73.)

Etymology From Greek, soros, heap, probably through the botanical term soredium, one type of reproductive body in the lichen, and sorediate, with surface patches like soredia.

Swarm stage (pseudoplasmodium): Rods 0 8 by 3 to 5 microns Attempts to cultivate have failed.

Fruiting body. Orange-red, irregularly lobed, consisting of a compact mass of small angular cysts. Average size of cysts 6 to 7 microns, smallest 3 microns, with thick and sharply defined edges. Rods 08 by 3 to 5 microns. The Krzemieniewskis (1927, loc. cit., 96) have described a variety, Sorangium sorediatum var. macrocystum, consisting of cysts 6 to 14 by 7 to 16 microns, about twice as large as in the type.

Source and habitat: Reported once by Thaxter (loc. cit) on rabbit dung from South Carolina. Krzemieniewski (1927, loc. cit.) common in Polish soils.

Illustrations: Tharter (loc. cit.) Pl. 27, Figs. 22-24. Quehl, Cent. f. Bakt., II Abt., 16, 1906, 9, Pl. 1, Fig. 2. Jahn, Kryptogamen-flora d. Mark Brandenburg, V, Pilze I, Lief. 2, 1911, 202, Fig. 1. Krzemieniewski, Acta Soc. Bot. Pol., 4, 1926, Pl. IV, Figs. 39-41. (1927, loc. cit.) Pl. V, Fig. 17, var. macrocystum Fig. 18.

 Sorangium cellulosum Imšenecki and Solntzeva. (Microbiology, Moscow, £, 1937, 7.)

Etymology: Modern Latin cellulosum, cellulose.

Fruiting body: Mature fruiting body rusty brown, 400 to 500 microns in diameter, sessile on layer of partially dried slime. No outer wall or limiting membrane. Composed of numerous cysts, irregular in shape 1.6 to 3.2 microns in diameter, each containing less than ten shortened rods. No discernable cysts wall or membrane.

Spores: 0.3 by 1.5 to 2.0 microns (no other data).

Vegetative cells: Flexible, rod-shaped cells with rounded ends, occurring singly; no flagella but motile by means of a crawling motion, 0.4 to 6 6 by 2.2 to 45 microns

Vegetative colony: No data.

Physiology: Good growth on stareb, cellulose. Decompose up to 24 per cent cellulose in ten days, but does not form fruiting bodies. Very poor growth on arabinose with formation of many involution forms including very much clongated

cells. Fail to grow on nutrient agar, washed agar, potato, carrot, milk.

Source: Isolated from soil.

Habitat: Soil. Decomposes organic matter.

4. Sorangium spumosum Krzemieniewski and Krzemienewska. (Acta Soc Bot. Poloniae, 5, 1927, 97.)

Etymology: Latin spumosus, frothy or foamy.

Swarm stage (pseudoplasmodium) Rods 0 7 to 0 9 by 2 6 to 5 2 microns

Fruiting bodies: Consist of numerous cysts, spherical or oval, not surrounded by a common membrane, but unsted into bodies embedded in alime Often in double or single rows. Cyst walls color-less, or slightly brown hish, transparent, so that the characteristic arrangement of the rods may be seen within Cysts 8 to 26 by 7 to 20 microns.

Source and habitat: Krzemieniewski (1927, loc. cit.) from Polish soil, isolated on rabbit dunc.

Illustrations: Krzemieniewski (1927, loc. cit.) Pl. V. Fig. 19.

 Sorangium septatum (Thavter) Jahn. (Polyangium septatum Thavter, Bot Gaz., 37, 1904, 412; Jahn, Benträge zur botanischen Protistologie. I Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 75)

Etymology: Latin saeptatus, fenced, i.e., divided by walls

Swarm stage (pseudoplasmodium) Rods 0.S to 1 by 3 to 5 microps

Fruiting bodies. Yellowish orange When dried, dark orange-red, 50 microns to more than 100 microns in diameter, cysts rounded or ovoid, angular or sylindrical, inner portion of the envelope divided into a variable number of recondary cysts. Cysts 18 to 22 by 12 to 22 microns in diameter. Secondary cysts 10 to 12 microns. The Krremieniewskis (1927, loc. cit., 90) recognize a Variety, Sorangium geolderin ast. micro variety for the program of the program

cystum, which has secondary cysts with dimensions 4 to 10 by 3 to 8 microns.

Source and habitat: Collected twice (Thaxter, Bot. Gaz., 57, 1904, 412) on horse dung in Cambridge, Mass. Reported by Krzemieniewski (Acta Soc. Bot. Poloniae, 6, 1927) as common in Polish soil.

Blustrations, Thaxter (loc. cit.) Pl. 27, Figs. 25-28. Jahn, Kryptogamen-flora d. Mark Brandenburg, V. Plue I. Lief 2, 1911, 202, Fig. 2. Krzemieniewski, Acta Soc Bot. Pol., 4, 1926, Pl. 27, Figs. 27-38; tbid., 1927, Pl. V, Fig. 15, var. microcystum, Fig. 16

6 Sorangium compositum (Thatter) Jahn (Polyangium compositum Thatter, Bot. Gar., 57, 1904, 413; Jahn, Beiträge zur botanische Protistologie I. Die Folyangiden, Geb. Borntrager, Leipzig, 1921, 74, Polyangium sorediatum Quehl, Cent f Bakt, II Abt., 16, 1906, 17, not Polyangium sorediatum Thaxter, ibid)

Etymology: Latin compositus, compound

Swarm stage (pseudoplasmodium): Not described

Geserious

Fruiting bodies: Dull yellowish-orango changing to dark red on drying. Rounded, mail, 0 5 to 1 mm, usually as a whole or even in larger clumps surrounded by a delicate and evanexcent membrane. In large fruiting bodies the cysts are bound together in balls 70 to 90 microns in diameter by a delicate membrane. The balls readily fall apart. Secondary cysts are angular, 7 by 11 microns, surrounded by a delicate orange-red membrane, about 0.4 micron in thickness. Length of rods in the cysts 5 micros.

Source and habitat Thaxter (loc. ett.) rabbit dung, South Carolina. Jalin (1901, loc ett.) found it four times on tabbit dung near Berlin, and taice on hare durg in Oberhary. Common in rolls of I'uland according to Krzemieniewski (1927, loc. ett.)

Hlustrations: Thaxter (loc. cit.) Pl. 27, Figs. 29-30. Jain (1924, loc. cit.) Pl. 1, Fig. 6. Krzemieniewski, Acta Soc. Bot. Pol., 4, 1926, Pl. III, Figs. 32-36; ibid., 1927, 6, Pl. IV, Figs. 7, 8, 9, 10, 11, 12; Pl. V, Figs. 13, 14; Pl. VI, Fig. 36.

 Sorangium nigrum Krzemieniewski.
 (Bull. Int. PAcad. Pol. Sci. et Lettres, Classe Sci. Math. et Nat., Scr. B, 15, 1937.)

Etymology: Latin niger, black.

Fruiting body: Primary cysts generally not formed; when observed, appeared as moke-colored slime envelope surrounding clumps of a few cysts. Secondary cysts usually arranged in rows within cellulose fibers, the material of the fiber forming a common sheath. Leah individual cyst inclosed by a cyst wall, clearly differentiated from the tubular-shaped cellulose fibers. Cysts measure to 10 fb y b to 23 microns; average 10 by 18 microns. Cyst wall moderately thick, colorless, transparent, becoming light brown with age, and finally black.

Spores: No data

Vegetative cells 1.1 to 1.3 by 2.5 to 5.5 microns.

Vegetative colony: Young colonies dead black in color On filter paper a bright orange margin is noted, the vegetative cells of which cover the cellulose fibers. On cotton cloth the margin is bright dirty-yellow, tinged with punk. Under low power magnification, center of the colony appears similar to matted fungal hyphae, due to characteristic compact accumulation of cysts and cellulose fibers.

Physiology: Cellulose fibers become swollen by the action of this organism, and become gray-brown with a violettinge Fibers lose the properties of cellulose and give no characteristic reactions

Source . Isolated from soil.

Habitat: Soil. Decomposes cellulose fibers.

Illustrations: Krzemieniewski (loc. cit.) Plate IV, Figs. 22-26.

8. Sorangium nigrescens Krzemieniewski. (Bull. Int. PAcad. Pol. Sci. et Lettres, Classe Sci. Math. et Nat., Scr. B, 16, 1937.)

Etymology: Latin nigrescens, becoming dark or black.

Fruiting body: Primary cysts vary in size up to 200 microns in diameter, irregular in shape and inclosed in a coloriess slime envelope. Formed by an accumulation of secondary cysts. Secondary cysts at first colorless, transparent, later becoming brownish with a limiting membrane; the young cysts appear dirty-yellow, the older ones grayishbrown to black. Color originates not only from the brownish cyst wall but from the gray mass of encysted cells. Secondary cysts measure 5 to 12 by 6 to 15 microns; average 6 by 10 microns. On filter paper not only well-formed primary cysts are formed, but also free secondary cysts are noted embedded in the slime of the colony.

Spores : No data.

Vegetative cells: 12 to 1.4 by 2.5 to 64
microns. Younger cells somewhat
shorter.

Vegetative colony: Mass of dark fruiting bodies develops at center of colony on filter paper; margin grayish-yellow. Cellulose fibers covered with vegetative cells on outside, and contain many cells within.

Physiology: Destroys cellulose, Cultivated six years with cellulose as carbon

Source: Isolated from sandy soil in pine woods in Ciemianka (?).

Habitat: Soil, Decomposes cellulose

nbers.
Illustrations: Krzemieniewski (loc. cit.) Plate III, Figs. 17-21.

#### FAMILY IV. POLYANGIACEAE JAHN

(Beiträge zur botan, Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924.)

Diagnosis: In the fruiting bodies the more or less abortened rods lie in rounded cysts of definite form. The well-defined wall is composed of hardened sline, and is yellow, red or brownish. The cysts may be united by a definitely visible slime membrane, the remnant of the vecetative slime, or they may be tightly appressed and cemented by the searcely visible remnants of the slime, or they may develop singly or in numbers on a stalk. In the more highly developed forms the stalk branches and carries the cysts at the tips of the branches.

#### Key to the genera of family Polyangiaceae.

 Cysts rounded, not stalked, usually many (one in Polyangium simplex) lying loosely in a slime membrane or closely appressed

Genus I. Polyangium, p. 1025.

- II. Cysts not as in I
  - A. Cysts pointed at the apex, often completely concrescent, and united to large disks or spheres
  - Genus II. Synangium, p. 1632.
    B. Cysts free, single or many on a stalk.
    - 1 Cysts forming a disk, flattened donoventrally, like the cap of a Boletus, on a white stalk

Genus III. Welittangium, p 1033

2. Cysts not forming a disk

a Cysts rounded or clongate, single on stalks.

Genus IV. Podangium, p. 1031.

an Cysts rounded or clongate or pointed, numerous on the ends of stalks which may be branched

Genus V. Chondromyces, p 1036.

### Genus I Polyanglum Link,

(Link, Mag d Ges Naturforsch. Freunde zu Berlin, 5, 1849, 42, Cystobacter Schroeter, in Cohn, Kryptogamenflora v Schlesien, 5, 1, 1856, 170, Myzobacter Thaater, Bot Gaz, 17, 1872, 311

Etymology Greek poly, many and angion, vessels, referring to the numerous cysts Disgress: Cysts rounded or coiled, surrounded by a well-developed membrane, culter free or mbedded in a second shired layer.

The type species is Polyangium ritellinum Link

#### Key to the species of genus Polyangium.

- I. Not parasitic on water plants (algae)
- A Sorus not white or gray sh in color
  - 1 Cysts rounded to spherical
    - a Ripe cysts yellow, reddish-yellow, orange or light red; not brown b. Cysts several or numerous and small.
      - e Not closely appressed
        - d Slime envelope transparent white or colorless.
          - e Usually 10 to 15 cysts. Rods in cysts, 3 microps long. Cysts 75 to 200 microps
            - 1 Pelyangum ritellinum.

ee. Cysts numerous. Rods 1.3 to 2.0 microns long. Cysts 20 to 80 microns.

5. Polyangium cellulosum.

- 2. Poluancium minus.
- dd. Slime envelope bright yellow.
- 3. Polyangium luteum. cc. Closely appressed; often polygonal due to pressure,
  - d. Bright vellow.
  - 4. Poluangium morula. dd. Orange.
- bb. Cysts single, large.
  - c. Large, 250 to 400 microns; reddish-yellow, 6. Polyangum simplex.
  - ec. Smaller, 30 to 60 by 50 to 130 microns; orange to light red.
- 7. Polyangium ochraceum. aa. Ripe cysts reddish-brown to dark brown.
- b. Cysts lying free, covered by a more or less definite slime envelope, c. About 60 microns in diameter: slime envelope delicate and colorless.
  - Polvanoium fuscum.
  - ec. About 35 microns in diameter; slime envelope vellow. 9. Polyanosum aureum
  - bb. Cysts rounded, in stellate arrangements on a slimy substrate.
- 10. Polyangium stellatum.
- Cysts elongate, coiled.
  - a. Cvsts brownish-red.
  - Polyangium ferrugineum. aa. Cysts bright orange-vellow. 12. Polyanojum indivisum,
- B. Sorus white or gray in color.
  - 1. Hvaline slime envelope white, foamy in appearance; cysta average 23 by
  - 34 microps. 13. Polyangium spumosum. 2. Sorus flat, crust-like, smoke-gray in color due to slime en elope; cysts average 36 by 44 microns.
- 11. Aquatic, parasitic on Cladophora.
- 14. Polyangium fumosum.
- 15 Polyangium parasiticum

Polyangium vitellinum Link. (Link, Mag. d Ges. Naturforschender Freunde zu Berlin, 3, 1809, 42; Muzobacter aureus Thaster, Bot Gaz, 17, 1892, 403 }

Etymology. Modern Latin vitellus,

like an egg volk Swarm stage (pseudoplasmodium). When rising to form cysts, milky white Rods large, cylindrical, rounded at either

end, 0.7 to 0 9 by 4 to 7 microns. Fruiting body: Cysts golden yellow, usually relatively spherical, 75 to 150

microns, occasionally 200 microns in diameter, almost always surrounded by a white slimy envelope, about 10 to 15 cysts in a mass. Rods in the cysts about 3 microns in length

Source and habitat : Thaxter (loc. cit.) on very wet wood and bark in swamps. Maine, Belmont. Jahn (1924, loc. cil.) states it is not common; on old wood, lying in moist ditches, also on old poplar bark which was kept moist in a dish, also found twice on rabbit dung.

Illustrations: Thaxter (loc. cit.) Pl.

25, Figs. 34-36. Zukal, Ber. d. deutsch Bot Ges., 15, 1897, 512, Pl. 27, Figs. 6-10. Jahn, Kryptogamenflora d Mark Brandenburg, V. Pilze I, Lief 2, 1911, 199, Fig. 3. Jahn, Beiträge zur botanischen Protistologie. I Die Polyangiden Geb. Borntracger, Leipzig, 1921, 77, and Pl. II, Fig. 13

2. Polyanglum minus Krzemieniewski. (Acta Soc. Bot. Poloniae, 4, 1926, 33 )

Etymology Latin minor, less or small. Swarm stage (pseudoplasmodium). Vegetative rods 04 to 06 by 3 to 7 microns.

Truiting bodies: Cyst masses commonly cover the substrate to an area of 0.5 so mm. Cysts are spherical or oval, small, 20 to 80 by 20 to 50 microns, light rose in color, becoming brownish, embedded in a transparent colorless slime Cyst membrane light colored. relatively thick, 0.5 to 1.0 micron, transparent, revealing the contents. Rods in cyst 0.8 to 1 0 by 1.3 to 2 0 microns.

Source and habitat. On rabbit dung sterilized and placed on soil (Poland) Rather rare Relatively slow in appearance, only after many days.

Blustrations : Krzemieniewski (loc cit ) Pl IV, Fig 47-48; Pl V, Fig. 49

 Polyangium luteum Krzemieniewski (Acta Soc Bot. Poloniae, 5, 1927, 98)

Ltymology Latin luteus, saffron- or golden-3 ellon

Swarm stage (pseudoplasmodium) Not described

Printing bodies Golden yellow, consisting of a few cysts surrounded by a common bright yellow very thick slime wall. The cysts have colorless than walls Rods 07 to 0.8 by 3.5 to 58 nucrons

Source and habitat. Iso'ated from soil on rabbit durg by Krzemieniczski (1927)

Illustration: Krzemieniewski (loc. cit.) Pl. V. Fig. 22, 23.

4. Polyangium morula Jahn. (Kryptogamenflora der Mark Brandenburg., V. Pilze I, 1911, 202.)

Etymology: Modern Latin from Greek mora, mulberry. A diminutive referring to shape of cysts.

Swarm stage (pseudoplasmodium): Not described.

Fruiting bodies: Cysts bright yellow, closely packed into a mulberry-shaped sorus; eysts with thick membrane (3 microns), often made polygonal by pressure, 20 to 35 microns, bound together by slime. The whole sorus is 100 to 200 microns broad Rods in cysts about 3 microns in length. Jahn states he has not studied fresh cysts. In the older evsts the rods are difficult to observe.

Source and babitat; Observed once only by Jahn (loc cit ) on rabbit dung. Blustration: Jahn (1924, loc cit.) Pl. 2, Γig 21

5. Polyangium cellulosum Imšenecki and Solntzeva . (On aerobic cellulosedecomposing bacteria Akademiia Nauk. Leningrad, Isvestiia, 1936, 1115; English summary, 1168 )

Ctymology: Modern Latin cellulosum. cellulose

Fruiting body, Rods at center of the colony non-motile, forming large orange aggregates Shorter than those at margin : 0.7 to 09 by 34 to 56 microns. Later a concentration of cells occurs. Rods come closer together, form rounded or oval aggregates from which eysts become delimited Cysts orange in color, 8 to 21 microns, average 20 to 23 microns. In addition to bacterial cells droplets of fat, 1.5 to 3.5 microps, are sometimes seen within the eyst. When treated with 11,50s, cysts are easily broken up under the cover glass. Fruiting bodies are composed of clumps of eysts. Fruiting bodies oval or pear-

<sup>\*</sup> Translated from the original by E. V. Prostov, Iowa State College Library, Ames. iowa

shaped, 40 to 55 by 110 to 160 microns, reddish-brown. Covered with a slime membrane (flakes of dried slime). Each composed of 12 to 40 cysts which become polygonal from pressure. No cystophore, except those formed from slimy threads which have a stratified structure. Cysts sometimes arranged in chains.

Spores: 0.7 to 0 8 by 2.2 to 3.5 microns. Vegetative cells: Thick, bent rods, with rounded ends, 0.8 to 1.2 by 3.5 to 8.5 microns. Motile, no flagella. Young rods have 1 chromatin granule, older have 2. Found in cellulose fibers at the margin of the colony. Fibers solidly stuffed near the margin. At the peripherty individual cells may be seen.

Vegetative colony: Cysts germinate on filter paper producing vegetative colonies. Colonies large, orange, moist, increasing in size. The older colonies have orange margins while the center is dark brown, corresponding to the color of the fruiting bodies Often show several concentric rings.

Physiology: Rods cover cellulose fibers, partially or completely destroying them. Paper becomes transparent.

Optimum temperature 18° to 22°C A

Grows only on wet cellulose; not in ordinary media No growth in a hanging drop of broth.

Aerobic.

Source and habitat : Soil.

Illustrations Imšenecki and Solntzeva (loc. cil.) Table II, 2, figures 1 to 5.

5a Polyangíum cellulosun var ferrugineum Mishustin. (Microbiology, Moscow. 7, 1938, 427)

Etymology. Latin ferrugineus, of the color of iron-rust

Fruting body: Composed of numerous cysts having definite wall Mass of rods has a yellowish tinge, and the cysts are colored reddish-yellow. Color probably confined to the cyst walls Cysts round or egg-shaped, or may be angular due to pressure. Each cyst contains numerous shortened rods Cysts usually 12 to 40

microns in diameter. Numerous cysts grouped into fruiting bodies having bright red or drabbish red color when ripe. Form of fruiting body variable: mest commonly rounded, ellipsoidal or biscuitishaped, sometimes sausage-shaped. Cysts confined by an orange-colored slime membrane or envelope. No cystophore present. Fruiting bodies not easily broken up. Vary in size from 80 to 240 microns.

Spores: No data.

Vegetative cells: Long, flexible, nonflagellate cells, motile by crawling, 08 to 1.2 by 3.0 to 5.0 microns. Become shortened and highly refractile during fruiting body formation.

Vegetative colony: On silica gel with cellulose at first pale pink. After six days fruiting bodies of red color appear, together with free cysts and many nonencysted shortened rods. Fruiting bodies numerous at center of colony. and later form in concentric rings around center. Margin of colony composed of vegetative cells; periphery pink. Mature colonies 2 to 5 cm in diameter, bright red, becoming drabbish red; pigmentation appears to be confined to limited Surface dull, moist. Margin not areas definite.

Physiology: Cellulose at center of colony completely destroyed; not entirely broken down under remainder of colony.

The author considers this a color variant of Polyangium cellulosum Imsenecki and Sointzeva.

Source: Isolated from the black soils of

Eastern European Russia. Habitat · Digests organic matter in soil.

5b Polyangium cellulosum var. fuscum Mishustin. (Microbiology, Moscow, 7, 1938, 427.)

Etymology: Latin fuscus, dark, swarthy, dusky, tawny.

Fruiting body Composed of individual cysts, each with separate cyst wall, and held together by a common slime meminane or envelope. Shortened redshaped spores inclosed within the cyst

walls. Cysts forming outside the large masses usually rounded; those within often polygonal or angular. Cysts 5 to 21 microns long, oval or egg\_shaped Encysted cells give cysts granular appearance. Ripe cysts brown to light brown in color; immature, yellow to pink. Fruiting bodies pinkish-yellow when young, becoming brown when ripened. Considerable variation in form: round, oval or sausage-shaped, and from 50 to 80 microns up to several hundred microns. Outer slime envelope office indistinct; no dried slime noticeable between the cysts.

Spores: No data

Vegetative cells: Identical with those of Polyangium cellulosum var ferru-

Vegetative colony: A faint yellow cast on cellulose-ailica gel after 2 to 3 days Becomes yellow-orange to yellow-pink after 6 to 8 days, while center is brownish-gray. Margin pinkish to yellow-pink Surface dull, moist. As fruiting bodies ripen, colony becomes darker, finally dark brown. Reaches diameter of 2 to 5 cm. Fruiting bodies often arranged in form of pigmented, closely set, concentre rings Margin of colony not clearly defined. Usually regularly rounded or oval. Cellulose completely destroyed only at center of flow.

Source. Common in black soils of Sumy Experiment Station. Found only once in rodgol soils

Habitat: Digests organic matter in soil 5c. Polyangium cellulosum var fulcum

Mishustin. (Microbiology, Moscow, 7, 1938, 427.)

Etymology Latin fulrus, reddishvellow rold-colored.

Fruiting body: lose or pink in color, composed of numerous cysts Young cysts yellow to yellow-orange, becoming pink, rose or red, or pinksth yellow. Cysts same shape as others of the species; 6 to 21 microns; contain many abort reds. Fruiting bodies vary in shape, often

elongated, flagella (?) -shaped (columnar?), up to 20 to 25 by 350 to 450 microns. Also globular, mace-shaped, etc. Usually 25 to 40 by 50 to 80 microns. Cysts unclosed by outer common envelope or slime membrane | Casily broken up mechanically.

Spores, No data.

Vegetative cells: 0.8 to 1.2 by 3 5 to 6 0

Vegetative colony: On cellulose-silica gel form a hardly visible white (colorless ?) colony at 2 days. After 6 days becomes pink in color. Fruiting bodies first form near center. After 9 to 10 days central area reddshépink while periphery has yellowish cast. Mature colony 2 5 to 7 5 cm in divineter, pinkorange color, fairly regularly round or oval in shape. Pigmented concentric pass of fruiting bodies.

Physiology Cellulose entirely destroyed at center of colony and often at other points

Agricultural Academy. Seldom in black soils of Sumy Experiment Station

Habitat Digests organic matter in soils.

5d Polyangium cellulosum var luteum Mishustin (Microbiology Moscow, 7, 1938, 427.)

Etymology: Latin luteus, saffron-yel-

Fruiting body Poorly organized agglomerations of colories to yellow cysts inclosing sporulated cells. Cysts regularly erg-shaped to oval, 8 to 20 microns in diameter, predominantly 6 to 10 microns. Matured cysts lovely connected into rounded or clongate murces 40 to 80 by 100 to 150 microns. Ripe fruiting bodies evils pulled apart.

Spores No data Vegetative cells Similar to others of the species.

Vegetative colony. On cellulose colonies regularly munded or oval, surface has maist appearance. Yellowish east 2nd or 3rd day, becoming deeper yellow.

Fruiting body: Colorless sori embedded in hyaline slime forming a common envelope around the cysts Surface white, foamy in appearance; cysts in irregularly rounded accumulations, 100 to 150 microns in diameter. Cysts usually spherical, sometimes elongate; 18 to 38 by 20 to 50 microns; average 28 by 34 microns. Cyst membrane colorless. Cysts contain bundles of shortened cells, a granular colorless mass, and a clear oleaginous fluid.

Spores: Shortened rods.

Vegetative cells: Straight rods, uniformly thick, with rounded ends: 06 to 0.8 by 3.9 to 6.8 microns.

Habitat: Soil.

Illustrations · Krzemieniewski (loc. cit.) Plates XVI-XVII, Figs. 10-13.

14. Polyangium fumosum Krzemieniewski (Acta Soc. Bol. Pol., 7, 1930.

253.) Etymology Latin fumosus, smoky Fruiting body . A flat, crust-like layer of 2 to 20 (or more) cysts arranged to form a sorus. Sori rounded, up to 90 microns in diameter, or irregularly shaped; often elongate up to 400 microns long Smokypray color due to surrounding slime walls. Outer profile of sheath (or cortex) irregular Cyst wall 2.4 to 3.5 microns thick: cysts often nearly spherical, 13 to 48 microns in diameter, though frequently elongate. Average 36 by 44

microns. Colorless, single, inclosed in a transparent membrane.

Spores : No data.

Vegetative cells: Long, straight, cylindrical with rounded ends; 0.7 to 09 by 2.7 to 5.7 microns. Encysted cells gimilar

Habitat : Soil.

Illustrations . Krzemieniewski (loc. cit.) Plate XVI, Figs. 6-9.

15. Polyangium parasiticum Geitler. (Arch. f. Protistenkunde, 50, 1921, 67.) Etymology. Latin parasiticus, parasitic.

Swarm stage (pseudoplasmodium); In water, on surface of the alga Cladophora. Pseudoplasmodia small. Rods long, cylindrie, rounded at end and 0.7 by 4 to 7 microns. At first saprophytic, later entering and destroying the Cladophora

Fruiting bodies: Sometimes single, usually 2 to 8 microscopically small, united in irregular masses, spherical or somewhat elongated. From 15 to 50 microns, usually 25 to 40 microns, with hyaline slime. When mature, red-brown in color, with firm wall.

Source and habitat: Found on Cladophora (fracta?) in pool at Vienna (Geitler,

Illustrations: Geitler (1924, loc. cit.) Figs 1-10.

# Genus II. Synangium Jahn.

(Jahn, Beiträge zur botan. Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1924, 79, Apelmocoena Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 243.) Etymology: Greek syn, together and angion, vessel, referring to the clustering of the cysts.

Diagnosis: Cysts provided with an apical point, united more or less completely to resette-shaped, hemispherical or spherical fruiting bodies.

The type species is Synangium sessile (Thaxter) Jahn.

# Key to the species of genus Synangium.

Cysts irregular, pointed, united as a rosette on a slimy base, without a stalk.

1. Synangium sessile.

 The fused cysts on a simple or branched stalk. A Cyst group spherical, with the points of the cysts covered as with hair, reddish. 2. Synangium lanuginosum.

B. Cyst group an oblate spheroid, yellow. Points of cysts less numerous.

3 Synanoium thaxteri.

 Synangium sessile (Thavter) Jahn (Chondromyces sessilis Thavter, Bot. Gaz., 57, 1904, 411; Jahn, Beiträge zur botanischen Protistologie I. Die Polyangiden, Geb. Borntraeger, Leipzig, 1024, 20)

Etymology: Latin sessilis, sessile, not stalked.

Swarm stage (pseudoplasmodium): Not described.

Fuiting body: Cysts form on the base a children or nester without trace of stalk. Diameter of rosettes 100 to 250 microns Individually the cysts are quite variable in form, irregularly spindle-shaped, usually short-pointed, wrinkled surface toward the tip. At the base they fuse or unite to irregular masses. Cysts 18 to 55 by 25 to 75 microns, average 40 by 50 microns.

Source and habitat: Thavter (loc. cit) found this on decaying wood in Florida Illustration. Thavter (loc. cit.) Pl. 27.

Figs. 14-15

 Synangium lanuginosum (Koßer) Jahn. (Chondromyceslanuginosus Koßer, Sitzber. d. Kais. Akad. Wiss Wien. Math.-Nat. Klasse, 122 Abt., 1913, 561; Jahn, Beitfäge zur botanischen Protistologie. I. Polyangiden, Geb. Borntracger, Leipzis, 1921, 19

Etymology: Latin lanuginesus, woolly Swarm stage (pseudoplasmodium): Not described

Pruiting body. Cyst cluster, consisting of united cysts, spherical or oval, 80 to 200 microns in diameter, when dry, dark firsh-colored, covered with hairs 15 to 50 microns long, originating from the individual cysts and giving the cyst cluster the appearance of a hairy ball. Skin

the cysts not definite. Rods within the cysts 3 to 6 microns The cyst clusters are terminal on more or less forked stalks, about 1 mm high

Source and habitat: Kofler (loc. cit.) found this on rabbit dung at Vienna.

Illustrations Kofler (loc. cit.) Pl 1,

3 Synangium thaxteri (Faull) Jahn. (Chondromyces thazteri Faull, Bot. Gar., 62, 1916, 226; Jahn, Betträge zur botanschen Protistologie, I Die Polyangiden Geb Borntraeger, Leipzig, 1921, 79) Regarded as a synonym of Synangium lanuginosum by Krzemieniewski, Acta Soc. Bot. Polonia, 4, 1903.

Ctymology, Named for Dr. Roland Thayter, American botanist

Swarm stage (pseudoplasmodium): Cultured for 2 years on dung, best in mixed cultures Rods 0.5 by 3 to 6 mucrons.

Fruiting body: Fruit cluster flattened, spherical, yellow to flesh color or red-dish-orange, with a stalk which varys in length, about 140 microns in diameter. The bristles corresponding to the single cysts are 15 to 30 microns long, at the base 10 to 12 microns wide. Sometimes cyst single, usually 370 t, occasionally 20 to 30. Rods 0.5 by 3 to 6 microns. Stalk maximum length 0.75 mm, usually 330 microns, single or branched. Broad based, narrowing to apiex and yellow in color. In germination tods more from basal sear of mendrane, leaving the empty sear, behind

Source and habitat On deer dung in

Ontario, Canada (Faull)

Illustrations Faull (for cit ) Pl. 5 and 6 Jahn (for cit ) Fig X, p 80.

### Genus III. Melittangium Jahn.

(Jahn, Beiträge zur Lotan, Protistologie. I. Die Polyangiden, Geb Borntraeger, Leipzig, 1921, 78)

Etymology: Greek melitta, bee and angion, wessel, because of the boney-comb pattern of the membrane.

Diagnosis: Cysts brownish orange-red, on short white stalk, like a mushroom. Has appearance of a white-stalked Boletus. The rods inside stand at right angles to the membrane. Upon germination the covering membrane is left colorless and with an appearance of honey-comb.

The type species is Melittangium boletus Jahn.

1. Melittangium boletus Jahn. (Beitrage zur botanischen Protistologie. I. Die Polyangiden, Geb. Borntraeger, Leipzig. 1924, 78.)

Etymology. Latin boletus, a kind of mushroom.

Swarm stage (pseudoplasmodium): No description

Fruiting bodies: Cyst stalked, mushroom-like, white when immature, then yellowish-flesh colored, finally yellowishbrown to nut brown, when dried more reddish-brown. Larger diameter of cyst about 100 microns, height 40 to 50 microns, length of white stalk about 40 microns, length of rods in the cyst 3 to 4 microns by 0.5 microns. Sometimes the cyst is smaller and spherical (50 to 60 microns diameter), sometimes there is fusion of neighboring cysts, occasionally the stalk is abortive.

Source and habitat: Jahn (loc. cit) found this not uncommon on rabbit and deer dung in the vicinity of Berlin, also on deer dung from Denmark. Krzemenienski (1927, loc. cit.) reported it as common in Polish soils.

Hlustrations: Jahn (loc. cil.), Pl. 2, Fig. 17 and 18. Also Fig B, p. 11, C-F, p. 23, O-Q, p. 43, T-U,p. 55. Krzemieniewski, Aeta Soc. Bot. Polonine, 4, 1925, 1, Pl. V, Fig. 55-56.

#### Genus IV. Podangium Jahn.

(Cystobacter Schroeter, in Cohn, Kryptogamenslora v. Schlesien, 3, 1, 1886, 170; Jahn, Beitruge zur botan Protistologie. I. Die Polyangiden, Geb. Borntrauger, Leipzig, 1924, 80, Monocysta Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 233 ) Etymology. Greek pus, poots, foot and angion, vessel.

Diagnosis Cysts chestnut-brown or red-brown, single on a more or less definite white stalk

White stark
The type species is Podangium erectum (Schroeter) Jahn.

# Key to the species of genus Podanglum.

I. Stalk scarcely definite, cysts short, appressed, if clongate then passing over from the white stem into the club-shaped cyst. Ripe cysts chestnut-brown.

1 Podangium ereclum.

- II. Stalk well differentiated
- A Cysts spherical, often irregular, confluent, the white stalk short.

  2. Padanaium lichenicolum.
  - B. Cysts lengthened ellipsoidal, red-brown, definitely differentiated from the white, slender stalks
    - Podangium gracilipes.
- 1. Podangium erectum (Schroeter) Jahn. (Cystobacter erectus Schroeter, in Cohn, Krytogamenflora v Schlesien, 3, 1, 1886, 170; Chondromyees erectus Thaxter, Bol Gaz, 23, 1897, 407, Jahn, Beiträge
- zur botanischen Protistologie. f. Die Polyangiden, Geb. Borntraeger, Leipzig. 1921 St.)
- Etymology Latin ereclus, erect, up-

Swarm stage (pseudoplasmodium) Kofler states rods are 2 to 5 microns in length.

Futiting bodies. Cysts usually short, almostspherical, compact, rounded above, orange-red changing to chestnut-brown, single on a white to yellow hypothallus constituted from the slime remaining bchind. A definite "foot" of whitsh slime is seldom observed. Itly to hundreds together Usually about 80 microns high and 40 to 50 microns broad above, smaller below, often spherical cysts 00 microns in diameter Rods in cysts 0 60 microns in diameter Rods in cysts 0 60 the microns.

Jahn believes the European form to be distinct from that described by Thaxter Thaxter's form produces cystophores 60 to 300 microns long which wither at maturity so that cysts appear sessile

Source and habitat: Thaxter (loc cit ), horse dung in laboratory cultures, Massachusetts. Kofler (Sktber. d. Kasa Akad Wiss. Wien. Math. Nat Klasse, 122 Abt , 1913), mouse dung. Jahn (1924) common on manure of different kinds, also on bark covered with lichens. Krzemensewski (Acta Soc. Bot. Pol. 5, 1927, 102) reported this species from Polish soil, but rare.

Illustrations Thaxter (toc cit ) Pt 31, Figs. 16-19. Quebl, Cent. f Bakt. II Abt., fd. 1900, Pt. l., Figs. 4 Jah. (toc. cit ) Pl. I, Figs. 7, 8, and 9 Krzemieniewski, Acta Soc Bot Polonice, 4, 1995. l. Pt. V. Fics. 82-84.

 Podangium lichenteolum (Thaxter) Jahn (Chondromyees lichenicolus Thuxter, Bot. Gaz. 17, 1892, 402; Jahn, Beiträge zur botanischen Protistologie.
 Die Polyangiden, Geb Borntracger, Leipzig, 1921, 51.)

Etymology: Greek lichen, tree mozs, lichen, Latin -colus, dwelling.

Swarm stage: Reddish, rods cylindrical, tapering slightly, 06 by 5 to 7 microns. Germinate readily after drying for 18 months when sown on moist

Fruiting bodies. Cysts single, rounded or irregularly lobed, often confluent. Cystophore short, squarish, often lacking or misshapen Cysts 28 to 35 microns, stem 7 to 8 by 10 microns.

Source and habitat: Thaxter (1892), parasite upon living lichens, which it destroys, New Haven, Conn Thaxter (1901, loc ett.), lichens, Indiana, on algae, seen on wet boards, in mill race, Massachusetts.

Illustrations Thaxter (1892, loc. cit)
Pl. 23, Figs 20 to 23 Quebl, Cent. f.
Bakt, II Abt, 16, 1906, 9, Pl 1, Fig 6.

3 Podangium gracilipes (Thavter) Jahn (Chondromyces gracilipes Thavter, Bot Gaz, 23, 1837, 105; Jahn, Betträge zur botanischen Protistologie. I. Die Polyangiden, Geb Borntraeger, Leipzig, 1921, 52)

Etymology Latin gracilipes, slender footed

Swarm stage Rods 5 to 7 microns.

Fruiting bodies Cysts bright orangered, or red, 25 by 35 microns, clongate, rounded, on a white pointed stalk, right and persistent on substratum, rods also in stall. Shortened rods in cyst 3 to 5 microns Cysts sometimes pear-shaped, endurous

Source and hishatt Thaxter (loc cit.), from rabbit dung, Mwaschusets Kofler (1913, loc cit.), dung, Vienna Jahn (loc cit.) relatively common. Twice on rabbit dung ner Berlin, once on gost dung in Norwa). Krzemieniewski (1927loc cit.) reported this species from Polish soil, but rare.

Illustrations Thaxter (loc. cit.) Pl 31, Figs 20-21 Quebl, Cent f. Bakt., H Abt., 16, 1996, Pl 1, Fig 12, Jahn (loc cit.) Pl II, Figs 19, 20 Kriemieniewski (1926, loc cit.), Pl V, Fig 51,

# Genus V. Chondromyces Berkeley and Curtis.

(See Berkeley, Introduction to Cryptogamie Botany, London, 1837, 313; Stigmatella Berkeley and Curtis, ibid. 1837, 313 (figure but no description); Berkeley (description), Notes on North American Fungi, Grevillea, 5, 1874, 97; see Berkeley and Curtis, in Saccardo, Sylloge Fungorum, 4, 1836, 679, Polycephalum? Kalchbrenner and Cooke, Grevillea, 9, 1830, 22; Myxobotyrs Zukal, Ber. d. deutsch. Bot. Gesellsch., 14, 1830, 316; Cystodersmia Enderlein, Bakterion-Cyclogenie, Berlin, 1924, 218

Synonymy: A species was figured and named in 1837 by Berkeley as Chondromyces crocatus Berkeley and Curtis, but not described. The generic name was finally described in 1874. Probably the date of the name should be the date of its description, although it is possible that an adequate labeled illustration should be interpreted as

valid publication.

Etymology: Greek chondres, grain and myces, (fungus).

Diagnosis: Cysts compactly grouped at the end of a colored stalk (cystophore). Cystophore simple or branched.

The type species is Chondromyces crocatus Berkeley and Curtis.

### Key to the species of genus Chondromyces.

I. Cysts not in chains.

- A. Cysts sessile when ripe.
  - 1. Cysts not pointed.
    - a. Cysts rounded. b. Yellow.
- Chondromyces crocatus.
- bb. Bright orange-red.
- Chondromyces aurantiacus.
- an. Cysts cylindrical.

  2. Cysts pointed.
- Chondromyces cylindricus.
   Chondromyces apiculatus.

ar again periodic

- B. Cysts borne on stalk or stipe when ripe.

   Cysts orange-colored and truncate or rounded at distal end.
  - a. Cystophore usually simple.
    - 5. Chondromyces pediculatus.
  - aa. Cystophore usually branched.

    6. Chondromyces medius.
  - Cyata copper-red when rape; pear-shaped.
     Chondromuces minor.
- II. Cysts in chains at end of a compact stalk.
- 8. Chondromyces catenulatus.

 Chondromyces crocatus Berkeley and Curtis. (Berkeley, Introduction to Cryptogamic Botany, London, 1857, 313; Berkeley, Notes on North American Fungi, Grevillen, 5, 1874, 61, Myzobotyrs variabilis Zukal, Ber. d. deutsch. bot Ges., 15, 1896, 340, according to Krzemuenewski, Acta Soc Bot Poloniae, 4, 1926, 33.) Etymology: Latin crocatus, saffron vellow.

Swarm stage (pseudoplusmodium):
Pale orange-red. Rods cylindrical or
tapering slightly, straight or slightly
curved, 0.0 to 0.7 by 2.5 to 6 microus.
Cultivated on nutruent agar and sterilized
horse dung. Cysts placed in moist
chamber germinate in one or two days.

The contents are first contracted within the cyst walls, showing the individual rods. The cyst wall is then absorbed or disappears at the base, and the rods escape in a regular stream until only the empty exit is left.

Truiting bodies: Cysts nearly conneal, rounded at tip, average 12 by 25 merons (6 to 20 by 15 to 45 merons), straw yellow, in spherical heads of variable numbers (70 to 90 micross) at tips of branches. Cystophore orange-colored, slender, striated, often twisted or regularly bent, simple or branched as many as 5 times. About 600 microns high, rarely 1 mm.

Source and habitat: Thavter (1892, loc. cit.), melon rind from South Carolina and old straw from Ceylon and Cambridge, Mass Zukal (loc cit.), Yuenna Quehl, dung from Java and on deer dung, near Berlin. Thavter (1904, loc cit.), New Haven, Conn , Tabor, Jowa, Plonda Laubach, Java

Illustrations: Berkeley, Introduction to Cryptogamic Botany, London, 1857, 313 Thavter, Bot Gaz, 17, 1892, 389, Pl 22 and 23, Figs 1-11 Quehl, Cent I Bakt., Il Abt, 16, 1906, 9, Pl 1, Fig 10 Jahn, Kryptogamenflora der Mark Brandenburg, V, Palze I, Lef 2, 1911, 199, Fig. 6 Jahn, Beiträge zur botanischen Protistologie, I. Die Polyangiden, Geb Bomitraeger, Leipzig, 1924, Pl 2, Figs 11, 15, and Id. 15.

2. Chondromyces aurantiaeus (Berkeles and Curtis) Thanter (Stigmatella aurantiaca Berkeles and Curtis (no description). Introduction to Crypto game Botany, London, 1857, 313, Berke ley (description), Notes on North American Pungi, Grevillea, 3, 1874, 97, Stilbum thytedosporum Berkeley and Browne, 1873, 96, see Saccardo, Salloge Fungorum, 4, 1896, 571, Polycephalum auranliacum Kalchbrenner hnd Australian Fungs, Grevilles, 9, 180, 23, Myrobotrys variabilis Zukal. deutsch, Hot. Ges , 14, 1896, 310, Chandromyces aurantiacus Jahn, Kryptogamenflora der Mark Brandenburg, V, Pilze I. 1911. 206)

Etymology Modern Latin aurantiacus,

Snarm stage (pseudoplasmodium)

Flanch-colored, distunctly reddish Rods
large, tapering somes hat, normally
straight, rounded at either extremity,
06 to 1 by 7 to 15 microns, average 05
by 7 microns (2) Lasily cultivated on
nutrient agar, but on this rarely produces
well formed cystophores, though cultivable on its ordinary substrate without
difficulty

Frutting bodies: Cysts oval, elliptical or spherical, average 30 by 50 microns, at first stalked then sessile, united in small numbers at one end of cystophores, bright orange-red, chestnut-brawn when kept most for a considerable period or flesh-colored. Cystophore colorless, of ten yellowish at the tru, usually simple, rarely forked, 200 to 400 microns high

The Krzemienienskis (Acta Soc Bot Polonice, 5, 1927, 96) have described a Chondromyces auranticus var fruitevera in which the fruiting body consists of a greenish, later yellowish mass of rods which develops into a thick cystophore with numerous terminal cysta. The cysts are oval or spherical, sometimes with cross-strations, first orange-solored, letter brown, about 40 to 120 by 23 to 30 microns. The cyst rods are 0.9 to 1.0 by 23 to 31 microns.

Source and habitat Berkeley (1857, loc et t), on helen Berkeley and Brown (1873, loc et t), on rotten wood from cylon Threver (1872, loc ett) in North America net uncommon on old wood and fung. Zukal (loc et t), Vicenar Thatter, Bot Gar, 25, 1877, 375, on antelope durg from Africa, Thatter, Bot Gar, 35, 1907, 405, Honda, Phalippines Quebl, Cent. f. Bakt., If Mt, 16, 1909, d. durg from Java Kire-mennesaki, Acta Soc Bot, Poloniac, 4, 1926, 1, are in Polish soil.

Illustrations Berkeley and Brown

(1873, loc. cit.) Pl. 4, Fig. 16. Kalchbrenner and Cooke (loc. cit.). Thaxter (1892, loc. cit.) Pl. 23 and 24, Figs. 12-19 and 25-28. Zukal (loc. cit.) Pl. 20. Quehl (loc. cit.) Pl. 1, Fig. 10. Jahn, Beiträge zur botanischen Protistologie, I. Die Folyangiden, Geb. Borntraeger, Leipzig, 1934, Fig. V, p. 57, Fig. W, p. 59. Krzemieniewski (1926, loc. cit.), Pl. V, Figs. 57-60, (1927) var. frutescens Pl. VI. Figs. 27-35

3. Chondromyces cylindricus Krzemieniewski. (Acta Soc. Bot. Pol., 7, 1930, 260.)

Etymology: Greek kylindrikos, cylindrical.

This organism was at first thought to be a variety of Chondromyces aurantiacus. It is separated from it on the basis of size, shape and pigmentation of the cysts.

Fruiting body: Cystophore composed of bundles of cells, develops from a thick, greenish-vellow mass of rods; unbranched or with short branches, colorless to pale orange-vellow: up to 200 microns high. Numerous cysts develop from cystophore and branches; at first borne on slender stine 20 microns long, later becoming sessile on evatophore. Young cysts orange-vellow, later becoming deeper orange, and finally bright orange-brown when ripe Shape variable: oval, irregularly rounded; predominantly cylindrical with rounded ends, 16 to 49 by 30 to 90 microns; average 29 by 56 microns. Spores: Shortened rods 0.8 to 1.1 by

Spores: Shortened rods 0.8 to 1.1 1 18 to 33 microns.

Vegetative cells: Long rods, tapered at ends, 0 5 to 0.6 by 6.7 to 11.0 microns. Habitat - Soils

Illustrations. Krzemieniewski (loc. cit ) Plate XVII, Fig 18

4 Chondromyces apiculatus Thaxter. (Bot. Gaz , 23, 1897, 405.)

Etymology Modern Latin from Latin apex, a point with a small point. Swarm stage (pseudoplasmodium).

Rods 1 by 3 to 20 microns Does not

grow as well on nutrient agar as Chondromyces crocatus and produces cysts and cystophores rarely. Cultivated on dung. Kofler states rods are 3 to 5 microns in length.

Fruiting bodies: Cysts of variable form, cylindrical to broadly turnip-shaped, usually with basal and apical appendages, the latter longer and pointed, bright orange, 28 by 35 microns. Cysts united in a single spherical terminal head, about 200 microns in diameter. Cystophore rigid, stiff, seldom branched, to 1 nm high, colorless, longitudinally striate. Cysts germinate at both base and aper.

Source and habitat: Thavter (1897, loc. cit.), on antelope dung from Africa. Thaxter (1904, loc. cit.), deer dung, Philippines, Florida. Baur (1906, loc cit.), on rabbit dung near Berlin. Kofler (1913, loc cit.), on rabbit dung near Vienna

Hlustrations: Thaxter (1897, loc. cit.)
Pl. 30, Figs 1 to 15. Quehl (1995, loc. cit.), Pl. 1, Figs 13 to 14. Jahn (1911, loc. cit.) p. 199, Fig. 5.

 Chondromyces pediculatus Thaxter. (Bot. Gaz., 57, 1904, 410.)

Etymology: From Latin pediculus, a small foot; small footed (stalked). Swarm stage (pseudoplasmodium): Rods 0 6 to 0 7 by 2 to 4 merons.

Fruiting bodies: Cysts tounded to bellshaped, truncate at distal end, orangeyellow, when dry orange-red, 35 to 50 microns. Sessile on stalks 40 to 60 microns in length, which are arranged as an umbel on the tip of the cystophore. Cystophore 300 to 700 microns in length, solitary, simple, usually rather slender and somewhat wrinkled.

Source and habitat: Thavter (loc. ett.), on goose dung in South Carolina.

Illustrations: Tharter (loc cit.) Pl. 26, Figs. 7 to 13.

 Chondromyces medius Krzemieniewski. (Acta Soc. Bot. Pol., 7, 1930, 263.) Etymology Latin medius, medial,

Pruiting body: Glistening, orange-colored cysts attached to cystophore in clusters by means of filamentous stupes about 40 microns long. Decudous. Mass of rod-shaped cells from which cystophore develops coloriess to pink. Cystophore composed of bundles of cells, often branched; appear similar to those of Chondromyeer ourantineus var fruter-cens. Cysts variable in shape; predominant are those rounded or flattened at the apex and tapered to and the base, 21 to 78 by 20 to 93 microns. Average 51 to 78 by 20 to 93 microns.

Spores: No data.

Habitat Soil.
Hustrations: Krzemieniewski (loc. cit.) Plate XVII. Figs. 20-22

7 Chondromyces minor Krzemieniewski (Acta Soc. Bot. Pol., 7, 1930, 265.) Etymology. Latin minor, less, little, appell.

Fruiting tody: Cell masses from which cystophore develops, reddish-violet in color Cystophore white, simple or branched, up to 120 microns high, 17 to 59 microns theke. Cysts force in clumps of 2 to 20 at apex of cystophore and branches on delicate colorless atipes Cysts mee red becoming copper-red a hen dry, pear-shaped, tapering toward base and broud at the apex; 20 to 47 by 20 to

65 microns; average 28 by 38 microns. Deciduous. Stipes 3 to 6 by 10 to 25

Spores: 0 6 to 0.8 by 2.9 to 4.3 microns. Vegetative cells: 0 6 by 3 8 to 7.2 microns.

Habitet - Soil

Illustrations: Krzemieniewski (loc. cut ) Plate XVII, Figs 23-24.

8. Chondromyces catenulatus Tharter. (Bot. Gaz., 57, 1904, 410 )

Etymology Modern Latin from catena, a chain, = occurring in chains.

Swarm stage (pseudoplasmodium): Cultivated only on original substrate. Rods 1 to 13 by 4 to 6 microps.

Fruiting bodies: Cysts light yelloworange, 20 to 50 by 18 microns in rosarylike chains, which may be branched once or twice, seesile on a short compute stalk, cysts separated by shrivedel isthmuses Chains to 200 microns. Cystophore simple 150 to 350 microns, eleft above, and passing over into the chains, rather broad at base and spreading somewhat on substratum The divisions of the cystophore are pointed, short and shelfth smollers.

Source and habitat Thaxter (loc. cit.), on decaying poplar wood, New Hampshire

Illustrations: Thaxter (loc. cit.) Pl. 26, Figs 1 to 5.

## FAMILY V. MYXOCOCCACEAE JAHN.

(Beitrage zur botan, Protistologie I. Die Polyangiden, Geb. Borntragger, Leipzig, 1924. 84.)

Diagnosis: The rods become shortened when fruiting occurs (resting cells are formed), and develop into spherical or ellipsoidal spores or microcysts. Upon germination the vegetative cell develops from the spore by a process analogous to budding, pinching off at the point of emergence, leaving the spore wall entirely empty. In three of the general definite fruiting bodies are produced. In Sporocytophaga, the spores (microcysts) are produced from the vegetative cells without development of fruiting hodice

## Key to the genera of family Myxococcaceae.

- I. Definite fruiting bodies formed.
  - A. Fruiting body not containing or made up of cysts.
    - 1. Fruiting bodies deliquescent. Genus I. Myzococcus, p. 1040.
    - 2. Fruiting bodies firm, not deliquescent.
    - Genus II. Chondrococcus, p. 1044. B. Fruiting body made up of cysts.
  - Genus III. Angiococcus, p. 1047.
- II No definite fruiting bodies formed. Genus IV. Sporocytophaga, p. 1048

## Genus 1. Myxococcus Thazter.

(Bot. Gaz., 17, 1892, 403.)

Etymology: Greek myza, mueus and kokkos, berry; slime sphere. Diagnosis: Spherical spores in conical or spherical or occasionally ovoid upright

fruiting bodies, united by a loose more or less mobile slime. The type species is Myzococcus fulvus (Cohn emend. Schroeter) Jahn.

# Key to the species of genus Myxococcus.

- I Stalk lacking or indicated only by a constriction.
  - A. Spores average less than 14 microns in diameter
    - 1. Fruiting body red or brownish-flesh color.
      - 1. Myzocorcus fulvus.
      - 2. Fruiting body light blood-red
    - 2. Myrococcus cruentus.
  - B. Spores average 2.0 microns in diameter. 1. Fruiting body yellow to greenish-yellow.
    - 3. Myrococcus virescens.
    - 2. Fruiting body yellow-orange to orange. 4. Myzococcus zanthus.
- Well developed stalk supporting spherical spore mass above.
- A Spores spherical.

- 5. Myzococcus stipitatus.
- B. Spores oval. 6. Murococcus ovalisporus.

1 Marococcus fulyus (Cohn emend. Calenator) John (Micrococcus fulcus Cohn? Reitrice r Riologie d Pflanzen # Heft 3 1875, 181: John (1924) states that the description of Cohn is too insidecusts to determine whether he was do ding with a true species of the genus Muracoccus Cohn described the organism from horse dung as producing control, rust-red droplets I mm in drameter the cells bound together by an intercellular slime, cells large, 1.5 microns in diameter, Micrococcus fulsus Schroeter, Schromycetes, in Cohn. Kryntogamenflora v. Schlesien, 3, 1, 1886, 144, Observed on borse dung and cabbit dung at versous localities John insists that this organism must be the same as Murococcus rubescens Tharter, Murococcus rubescens Thanter Bot. Gaz. 17. 1802, 403, Murococcus ruber Baur, Arch. f. Protistenkunde, 5, 1905, 95, Muracoccus puriformis A. L. Smith Jour Bot . 50, 1901, 71; Muzococcus paranensis de Kruyff, Cent. f. Bakt. II Abt . 21, 1908. 356, Ehodococcus fulrus Winslow and Winslow, Systematic Relationships of the Coccaceae, 1908, 262: Muzococcus fultus Jahn Beiträge sur hotanischen Protestologie, I. Die Polyangiden, Geb Borntracger, Leipzig, 1921, 81)

Etymology Latin fulrus, reddish-

Swarm stage (pseudoplasmodium). Thanter states that the rod masses are reddish, rods slender, irregularly curved, 0 t by 3 to 7 microns. Bauer followed errore permination in hanging drop Stores 0 S to 1.3 micmas, without structure, in five hours swollen to 1 to 1.5 microns, and no lorger as refractive The meribrane is not burst; the cell becomes cor shaped, then concate and extendric He regards his Muzococcus enter as distinct from Thanter's Marocovers to except in part because of differences in spore germination. The cells Lea me matile after doubling or trobling in leigth. It is a creening rootson in motort with the substrate; the cells do not "swim." Rate of motion 5 to 10 microns per minute. Rods eventually are 0 5 to 0 7 microns by 4 to 10 nicrons. Cell division by transverse fission. Spore formation is through shortening and rounding of the cells, the converse of germination. In hanging drop the cells tend to congregate after three days and to transform into spores. Rods sporulate in 3 to 1 hours The rods continue to congregate, and the spore mass increases, held together by viscous matrix. Vesetative cells are licht fields cultured.

Gelatin is quickly liquefied, completely in 1 to 2 days, but no fruiting bodies are formed

Koffer secured good growth on Hast-

ing's milk agar, and determined digestion of casein.

Baur could not secure good growth on any agar medium of krown composition. With peptone, sugars, etc., some growth

With peptone, sugars, etc., some growth but not normal when peptone present. He carried one strain 31 months on peptone sugar agar. Good growth on dung agar. Addition of peptone to dung agar not significant in effect, the addition of glucose altered the form of the fruiting bodies.

De Krust greuted best results with a De Krust greute with a with a contract of the strain of the

De hrus it secured best results with a dung extract agar to which was added ammonium nitrate and potassium phosphate.

Frusting bodies; Spherical or elongate pear-shape, constricted below, often with definite slimy stalk, fesh red to brownish-red, when dry rust-red to brown, about 300 metrons in diameter. Spores 1 to 12 mirrons John (1921, loc cit ) notes two saricties.

var albus (Latin albus, white).
Constantly white, even when
transferred. Fruiting bodies somewhat smaller than the type.

var. ministus. (Latin ministus, painted with ted lead or cinnabar.) Color cinnabar-red, fruiting bodies son ewhat larger.

The form described by de Kruyff had spores I 6 n icrons in done ster.

Source and habitat: Thaxter (1892, loc. cit.), on various decaying substances, lichens, paper, dung, etc. Smith flaccit.), on rabbit dung from Wales. Baur (loc. cit.), on cow and dog dung. De Kruyff (loc. cit.), on stable manure in Java. Jahn (1924, loc. cit.), very common, on almost all specimens of dung. also on bark, decaying wood, and lichens. Krzemieniewski (1927, loc, cit.) verv common in Polish soil. Kofler (loc. cit.). dung of rabbit, horse, goat, mouse, roe, deer, on stem of clematis and decaying leaves and in bird nest.

Illustrations: Cohn (loc. cit.) Pl. 6, Fig. 18. Smith (loc. cit.) Fig. 1. Baur (loc. cit.) Figs. 1, 2, 3, and Pl. 4. Figs. 1-13, 16. Jahn (1924, loc. cit.) Figs. I.-M, p 43, Fig. R, p. 47. Krzemieniewski, Acta Soc Bot. Poloniae, 4, 1926, Pl. I. Figs. 7-8, Kofler, Sitzber. d Kais, Akad, Wiss, Wien, Math.-Nat. Klasse, 122 Abt., 1913, 845, Pl. 2, Figs. 10 and 12.

Cultures: Baur (loc. cit.) states that he deposited a pure culture in the Zentraistelle für Pilzkulturen.

2. Myxococcus cruentus Thaxter. (Thaxter, Bot. Gaz., 23, 1897, 395; Chondrococcus cruentus Krzemieniewski. Acta Soc. Bot Poloniae, 5, 1927, 79.)

Etymology: Latin cruentus, blood-red. Swarm stage (pseudoplasmodium): Rods 0.8 by 3 to 8 microns Was not cultivated.

Fruiting body: Cysts regularly spherical, 90 to 125 microns, blood-red. Slime forms on the surface a more or less definite membrane, in which the spores Spores aval or irregularly oblong about 09 to 1 by 12 to 14 microns. Cysts are densely aggregated.

Source and habitat : Tharter (loc. cit ). on cow dung, Tennessee. Krzemieniewski (1927, loc. cit.) rare in Polish soils.

Illustrations Thaxter (loc. cit.) Pl 31, Figs. 28-29.

3. Myzococcus virescens Thaxter. (Bot. Gaz., 17, 1892, 404.)

Etymology: Latin virescens, becoming green.

Swarm stage (pseudoplasmodium); Rod masses greenish-yellow. Rods slender, irregularly curved, 0.4 by 3 to 7 microns. When cultivated in potato agar tends to lose its green color and becomes yellowish, Badian (1930) reports the presence of a dumb-bell-shaped nuclear structure which splits longitudinally in cell division, and shows autogamy preceding and a reduction division during spore formation.

Fruiting body: Spherical or conical. usually less rounded than other species of the genus, yellowish, occasionally greenish, in culture on artificial media, easily becoming white, 150 to 500 microns. The slime deliquesces in continued moisture. Spores large, about 2 microns.

Source and habitat : Thaxter (loc. eit.), on hen's and dog's dung, New England. Jahn (1924, loc. cit.), not very abundant on dung of rabbit, horse, stag and black cock. Krzemieniewski (1927, loc. cit.), common in soil in Poland. Badian (loc. cit.), Poland.

Illustrations: Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. I, Fig. 9. Badian, Acta Soc. Bot. Polonise, 7, 1930, 55. Pl. 1. 8 figures.

4. Myxococcus xanthus Beebe. (Jour. Bact., 42, 1941, 193.)

Etymology: Greek zanthos, orange, golden.

Fruiting body: Spherical to subspherical, usually sessile but occasionally constricted at the base giving the appearance of a short stalk or foot. Mature fruiting body up to 300 to 400 microns in diameter, often slightly flattened on top or one side. Color varies from light yellowish-orange when young to bright orange when mature; color constant, never tending toward greenish-yellow. No outer cyst wall or

limiting membrane discernible, the spores being imbedded in the slime holding the mass together. Usually single, though two or three fruiting bodies may become jouned to form an irregular mass; each is attached to the substrate, however, and never bud one from another.

Spores. Spherical, with thick outer wall or membrane. Highly refractile. Stain very easily with any of the ordinary bacterial or nuclear dyes 20 microns in diameter, seldom larger.

Vegetative cells : Large, flevible, single, Gram-negative rods with rounded ends. No flagella, but move on surface of soid or semi-solid substrate with a crawling or creeping motion. Vary in size from 0.5 to 10 by 4 to 10 microns, average 0.75 by 5 microns. More or less distinct cell wall often evident.

Vegetative colony: Characteristics

On plain 1.5 per cent agar (no nutrients added): Very thin and transparent, often hardly visible except by transmitted light. Little or no pigmentation. Surface covered with line, more or less regularly spaced ridges causing a dull macro-copic appearance without gloss or sheen. Margin very thin and quute regular.

On rubbit dung decoction agar Colony thicker, the surface being broken by vens or ridges radiating from the center. Thickecentral area often smooth and glossy while margin much the same as that on plain agar. Vens or ridges extend outward from center in lower pural, always in clock-wise direction Pigmentation, yellon to pile orange, confined to thicker central portion, extends part way along viens to margin

On nutrient rair Growth poor Colony thick, at first heavily veined, the seins later merging to form an irregular glosy surface. Colony remains small, pagmentation usually fairly heavy, riargin thick, irregular to behate

Physiology: Grows well on mineral

salt-agar to which has been added dulcitol, inuln, cellulose, reprecipitated cellulose or starch; hydrolyzes starch; does not destroy cellulose to any appreciable extent. Best growth on suspension of killed bacterial cells in agar; suspended cells in growth area lysed. Development completely inhibited by arabinose, larely by malanes and manuse.

Source: Isolated from dried con dung, Ames, Iona.

Habitat Decomposed bacterial cells in dung.

Illustrations · Beebe (loc. cit.) Figs. 1-28

5 Myxococcus stipitatus Tharter. (Bot. Gaz , 23, 1897, 395 )

Ltymology. From Latin slipes, stalk; stalked

Swarm stage (pseudoplasmodum): Rods 0.5 to 0.7 by 2 to 7 microns or longer. Grows well on nutrient agar, but does not fruit readily

Fruting body: Spore mass nearly spherical, 175 microns in drameter, deliquescent, sessile on a well developed compact stalk, white to yellowish and flesh color. Spores 0.8 to 1.2 by 10 to 115 microns. Stalk 100 to 200 microns long, 30 to 50 microns wide.

Source and habitat Thavter (loc. cit.), repeatedly on dung in laboratory cultures at Cambridge, Mass., Maine, Tennessee Krzemieniewski (1927, loc. cit.), common in Polish soils.

Illustrations, Tharter (loc. cit.) Pl. 31, Figs. 30 to 33, Krzemieniewski, Acta Soc. Bot. Poloniae, 4, 1926, Pl. 11, Figs. 13-14.

6 Myzococcus ovalisporus Krzemieniewski (Acta Soc Bot , Pol , 4, 1926, 15) Etymology Modern Latin oralis, oval, Greek sporos, seed Oval spored.

Swarm stage (pseud-plasmodum); Not described,

Fruiting lexiles Produces alreat spherical, characteristically abortened, until

spore masses of light milky yellow color. These are often raised on a poorly develoned stalk. This stalk always shows some bacterial cells remaining, and in this and color is differentiated from M. stipilatus. From the base of the stalk or directly from the substrate one or more small fruiting bodies develop. Spores are oval, sometimes irregularly spherical, 1.3 to 1.9 by 1.0 to 1.4 microns. In culture retains its differences from Muzococcus stipitatus. The latter sporulates best at room temperature, but

Muxococcus oralisporus in an incubator (presumably at 37°C).

Source and habitat : Develors on rabbit dung (sterilized) on soil in Poland (Krzemieniewski).

Appendix: Rippel and Flehmig (Arch. f. Mikrobiol., 4, 1933, 229) describe a new type of aerobic cellulose destroying bacteria under the new genny name of Itersonia. This genus includes a single species, Hersonia ferruginea. This organism shows similarity to those included in Muzococcus.

#### Genus 11. Chandrococcus John.

(Jahn, Beitrüge zur botan, Protistologie, I. Die Polyangiden, Geb. Borntraeger, Leinzig. 1921; Dactylocoena Enderlein, Bakterien-Cyclogenie, Berlin, 1924, 243.)

Synonymy . A segregate from Myzococcus Thaxter.

Etymology: Greek chondros, grain and kollos, ball (coccus).

Diagnosis: Spores embedded in a viscous slime which hardens. Fruning bodies divided by joints or constrictions, often branched, usually relatively small,

Seven species are included, of which the first described by Tharter and best described, Chondrococcus corolloides (Tharter) Jahn, may be designated as the type The first species listed by Jahn is regarded as doubtful and should not be regarded as the type for there is no evidence that Jahn ever saw the species.

# Key to the species of genus Chondrococcus-

I. Not parasitic on fish.

A. Erect, simple or somewhat branched fruiting bodies.

1. Secondary fruiting bodies not produced.

a. Fruiting bodies constricted or jointed.

1. Chandrococcus coralloides.

aa. Fruiting body simple, columnar, club- or cushion-shaped. b Fruiting body thick below, lesser above.

2. Chandrococcus cirrhosis.

bb. Not as in b.

c. Spores 16 to 26 microns in diameter.

d Fruiting body cushion-shaped. 3. Chondrococcus megalosporus.

dd. Fruiting body branched.

4. Chondrococcus macrosporus.

cc. Fruiting body smaller below, above club shaped. Spores 1.0 to 1.2 microns in diameter.

1a. Chondrococcus carallaides var.

claratus. 2. Secondary fruiting bodies arise as bud-, finger- or coral-like growths from primary fruiting body.

5. Chondrococcus blasticus. B. Recumbent, simple swelling or cyst heap constituting the fruiting body.